



Chronology of KSC and KSC Related Events for 2003

Elaine E. Liston

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FOREWORD

This 2003 Chronology is published to describe and document KSC's role in NASA's progress.

Materials for this Chronology were selected from a number of published sources. The document records KSC events of interest to historians and other researchers. Arrangement is by date of occurrence, though the source cited may be dated one or more days after the event.

Materials were researched and prepared for publication by Archivist Elaine E. Liston.

Comment on the Chronology should be directed to the John F. Kennedy Space Center, Archives, LIBRARY-E, Kennedy Space Center, Florida, 32899. The Archivist may also be reached by e-mail at Elaine.Liston-1@ksc.nasa.gov, or (321) 867-1515.

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Space Shuttle Columbia leaps off Launch Pad 39A and races toward space on missions STS-107. Following a flawless and uneventful countdown, liftoff occurred on-time at 10:39 a.m. EST. The 16-day research mission will include FREESTAR (Fast Reaction Experiments Enabling Science, Technology, Applications and Research) and the SHI Research Double Module (SHI/RDM), known as SPACEHAB. Experiments on the module range from material sciences to life sciences.. Landing of Columbia is scheduled at about 8:53 a.m. EST on Saturday, Feb. 1. This mission is the first Shuttle mission of 2003. Mission STS-107 is the 28th flight of the orbiter Columbia and the 113th flight overall in NASA's Space Shuttle program.

JANUARY

January 1: In 2003, astronauts will lengthen the wingspan of the International Space Station almost threefold. This year will see as many as six shuttle flights from Kennedy Space Center. The first one is set to begin in about two weeks as Columbia embarks upon a science mission. The rest of the shuttle flights this year will soar to the International Space Station. By early 2004, the station will have most of its domestic parts. The year's first shuttle flight will send the first Israeli, Ilan Ramon, into space. The seven people on board will work two shifts a day for 16 days to complete a science research mission. Columbia initially was slated to fly in 2002, but cracks in the shuttle fleet's fuel liners forced NASA to juggle its shuttle launch lineup late in the year. Station missions took priority over the science flight. ["NASA faces challenging year for space station construction," **Florida Today**, p 1A & 2A.]

January 2: NASA was smart to move its space shuttle overhaul operation from California to the Kennedy Space Center, but could have done a better job of explaining the decision, the General Accounting Office said in a letter released Thursday. The National Aeronautics and Space Administration announced early last year that it was moving the operation, which performs the major repairs and upgrades to the shuttle fleet, from Palmdale, Calif., to Florida. Until last year, the work called Orbiter Major Modification almost was exclusively done at a Boeing-owned Palmdale facility where all five orbiters were built. Every three years, each orbiter is thoroughly inspected and upgraded. ["NASA was right to transfer repairs to Florida, GAO says," **Orlando Sentinel**, January 3, 2002, p A10. "GAO: Reason for shuttle transfer vague," **Florida Today**, January 3, 2002, p 1A.]

◆ The launch of the ICESat (Ice Cloud and land Elevation Satellite) and CHIPSat (Cosmic Hot Interstellar Plasma Spectrometer) polar-orbiting satellites for NASA aboard a Boeing Delta II rocket has been retargeted to occur on Friday, January 10. This launch date is predicated on the availability of the downrange instrumentation aircraft. Should the aircraft not be available that day due to other tracking support requirements, then launch will be rescheduled for January 11. Liftoff of the Delta II will be from NASA's Space Launch Complex 2 (SLC-2) at Vandenberg Air Force Base, Calif. The 45-minute launch window on Jan. 10-11 extends from 4:45 p.m. – 5:30 p.m. PST. ["ICESAT/CHIPSAT Ready For Launch Aboard Delta II Rocket on Jan. 10," **NASA News Release #001-03**, January 2, 2003.]

January 3: NASA should have more information next week on whether a crack found in a part in shuttle Discovery has the potential to delay Columbia's Jan. 16 launch. The crack was in a plum-size metal ball that is part of a support inside the liquid oxygen line. The problem didn't appear widespread as inspections of other orbiters commenced. NASA, however, is more concerned with proving that even a damaged ball won't pose a danger. Then an inspection of Columbia, which is on the launch pad, won't be necessary. Continuing tests on spare parts should produce results by next week, Kelly Beck, lead flight director for the Columbia mission, said Friday. ["Crack might delay launch," **Florida Today**, January 4, 2003, p 1B.]

January 4: NASA is moving up the launch of two satellites that will measure ice sheets and hot plasma. The first launch attempt, from Vandenberg Air Force Base in California, will be Friday instead of Saturday because of the availability of downrange instrumentation aircraft need to support the launch. If the aircraft are needed for other duty on Friday, NASA will try again the next day. Either day, the Delta 2 rocket carrying the pair of science satellites is expected to lift off between 7:45 and 8:30 p.m. EST. ["NASA resets 2 launches," **Florida Today**, January 5, 2003, p 3B.]

◆ United Space Alliance hired 176 new employees at Kennedy Space Center after NASA consolidated shuttle modification work near the Florida launch site, ending a long-standing practice of doing major modifications in Palmdale, Calif. At least twice as many workers were doing the same work at the facility in Palmdale. Florida politicians and economic development officials have hailed the move, saying NASA's bid to streamline shuttle operations is not only smart for the agency but beneficial for workers here. When administrator Sean O'Keefe announced the decision, NASA estimated the move would mean 230 new jobs. Instead, an audit released this week by the U.S. General Accounting Office said the agency's prime contractor, United Space Alliance, has so far been able to meet the need with 176 new hires. ["Space Alliance uses fewer shuttle workers," **Florida Today**, January 5, 2003, p 3B.]

January 5: A man stole a small plane at gunpoint Sunday and threatened to crash it into the European Central Bank in Frankfurt, prompting evacuations and sowing fear in the German financial capital. He landed safely after about two hours and was arrested, police said. The man told a television station during the drama that he meant to call attention to Judith Resnik, a U.S. astronaut killed in the 1986 post-launch explosion of the space shuttle Challenger. Web posted. (2003). [Plane Hijacked in Germany in Effort to Draw Attention to Challenger Astronaut Judith Resnik [Online]. Available WWW: <http://www.space.com/> [2003, January 5].]

January 7: The launch of the ICESat and CHIPSat polar-orbiting satellites for NASA aboard a Boeing Delta II rocket from Vandenberg AFB was postponed from its Dec. 19 launch date. A review of test data uncovered a problem within an ordnance box. The difficulty was associated with the signal the unit provides for launch vehicle devices to unlatch and separate the payload fairing. The removal and replacement of this unit, and the associated retest, was expected to take about two weeks. The new launch date has been targeted for Friday, Jan. 10. The 45 minute launch window extends from 7:45 to 8:30 p.m. EST. ["Polar satellites now due to launch Jan. 10 from Vandenberg AFB," **KSC Countdown**, January 7, 2003.]

◆ Kicking off the new year, the international crew for mission STS-114 spent last weekend at KSC taking part in Crew Equipment Interface Test activities. The crew comprises Commander Eileen Collins, Pilot James Kelly, and Mission Specialists Soichi Noguchi and Stephen Robinson. Noguchi represents NASDA, the Japanese space agency. The mission is a Utilization and Logistics Flight (ULF-1), carrying the MPLM Raffaello, with supplies and equipment and the External Stowage Platform (ESP-2) to the station. . ["Crew preps for March 1 launch on STS-114," **KSC Countdown**, January 7, 2003.]

◆ The first Israeli astronaut makes this month's shuttle mission a high-profile target, NASA's security chief says, but security hasn't increased tremendously for the Jan. 16 launch. The latest delay for Columbia, which was supposed to launch in July, gave NASA more time to prepare for possible terrorist threats, but all launches have been under tighter security since the attacks of Sept. 11, 2001. "The additional time has helped us, but it hasn't been critical," David Saleeba, a former Secret Service agent, said Thursday. Some security measures have been under review for possible easing in the near future, he said, and more members of the public may be allowed into future launches, too. ["NASA fine-tunes launch safety," **Florida Today**, January 8, 2003, p 1B.]

January 8: From Oct. 1, 2001, to Sept. 30, the Federal Aviation Administration reported 13 planes flying within 30 miles of the shuttle pads near launch time. But since Oct. 1, there have been 17 violations. All of the intrusions into this temporary flight restriction have been mistakes, people just out for a flight who didn't check the FAA's Notices to Airmen – regular bulletins that tell pilots of the current restrictions. During the last shuttle mission, one pilot caught in the restricted zone refused to land until he got into Volusia County. Fighter jets forced an errant helicopter from Miami down into a field on Merritt Island during the first shuttle launch after Sept. 11, 2001. The pilot hadn't been flying in some time and wasn't aware of the restricted area. The FAA publicizes the restricted flight area and time 48 hours before launch. In 1999, a single-engine airplane crashed during a storm on Cape Canaveral Air Force Station. The pilot died in the accident. ["KSC launch rules keep pilots down," **Florida Today**, January 9, 2003, p 1A & 10A.]

January 9: Shuttle Update: Discovery – An engineering evaluation continues following the discovery late last year of a surface crack in a 2.25-inch diameter metal ball associated with a tie rod assembly inside a 17-inch liquid oxygen line. Further inspections of similar assemblies in Discovery's 17-inch and 12-inch lines have found no cracks. Inspections of Atlantis and Endeavour also have found no cracks. Atlantis continues to be processed for its March launch to the International Space Station. Preparations continue to install the Forward Reaction Control System. All three Space Shuttle Main Engines have been installed and leak checks are complete. Endeavour – Deservicing and processing continues for the STS-115 mission to the International Space Station scheduled in May 2003. Throughout the holidays, work continued with waterproofing operations, structural inspections of the orbiter's leading edge and the Forward Reaction Control System. Removal of the FRCS was also completed. Checkout on the Orbiter Maneuvering System

Pod is in work as is MEC/PIC verification. Preparations for fuel cell single cell voltage test are also in work. Columbia – Launch preparations are under way at Pad 39A for the Shuttle's Jan. 16 launch on the Spacehab microgravity research mission. ["No cracks found in orbiters' fuel lines," **KSC Countdown**, January 9, 2003.]

◆ The launch of NASA's ICESat and CHIPSat spacecraft aboard a Boeing Delta II rocket is now scheduled for Saturday, Jan. 11, at 7:45 p.m. EST from Vandenberg Air Force Base, Calif. The possible launch attempt on Friday, Jan. 10 will not be made. ["ELV launch at Vandenberg AFB now set for Saturday," **KSC Countdown**, January 9, 2003.]

◆ Shuttle managers aren't satisfied with tests on parts like one that was cracked in Discovery, but the shuttle program chief is optimistic Columbia will launch Jan. 16 as scheduled. Shuttle mission managers held a formal launch readiness review on Thursday at Kennedy Space Center, but decided more testing was needed before Columbia is cleared for launch, shuttle program manager Ron Dittmore said. "We don't have any real indications that look like this is going to be a show-stopper for us," he said. Shuttle managers will review data from tests Sunday to make sure they are ready to proceed with the countdown, which gets under way overnight Sunday. The crew goes into quarantine tomorrow. Since Columbia is on the launch pad, shuttle managers hope to avoid inspecting it, which could cause a launch delay. ["Shuttle manager optimistic Columbia will make countdown," **Florida Today**, January 10, 2003, p 1B.]

◆ NASA's John F. Kennedy Space Center has awarded a firm fixed price contract for the construction of a second Operations Support Building (OSB II) to David Boland, Inc., Titusville, Fla. The OSB II will be located in the Launch Complex 39 area near the Vehicle Assembly Building. Existing modular housing and trailers will be demolished to make way for the new six-story, 189,000-square-foot building. The OSB II will provide 784 permanent office spaces, 16 training rooms, computer rooms, multimedia conference rooms, a 352-person Mission Conference Center with an observation deck, technical libraries, and an Exchange store. The contract award amount is \$23,969,000. The performance period is 835 calendar days, or approximately 27 months, with a projected completion date of April 29, 2005. David Boland, Inc., is a small business HUBZone firm. This is the largest award to a HUBZone firm by Kennedy Space Center. ["David Boland, Inc. Awarded KSC Construction Contract," **NASA News Release #3-03**, January 9, 2003.]

January 11: The presence of an Israeli fighter pilot, who has flown combat missions against Arab interests, aboard an American space shuttle raised obvious questions about security and terrorism even before Sept. 11, 2001. But the heavy security blanket covering Brevard's spaceport this month – from snipers watching over the astronauts from helicopters to the combat air patrols by fighter jets to the deployment of mobile missile launchers along the Cape's beaches – is not about one shuttle launch. Instead, NASA and the U.S. Air Force officials say they're concerned about protecting all of NASA's shuttles and space assets. Between now and Feb. 2, not only is shuttle Columbia launching, but three expendable rockets carrying critical military payloads are set to launch too. Neither the Air Force nor NASA would comment on weapons or plans. ["KSC security tighter than ever," **Florida Today**, January 12, 2003, p 1A.]

◆ NASA officials postponed the launch of a rocket carrying two Earth-orbiting satellites Saturday due to mechanical problems but said they would attempt to launch the Delta II rocket Sunday (January 12). Engineers were unable to load helium into the rocket, which is needed to propel the craft into space, said NASA spokesman Dave Steitz, from Vandenberg Air Force Base. The Delta II is scheduled to carry the Ice Cloud and Land Elevation Satellite, or ICESat and the CHIPSat, Cosmic Hot Interstellar Plasma Spectrometer satellite. ["Mechanical woes delay launch of two satellites," **Florida Today**, January 12, 2003, p 7A.]

January 12: NASA's Ice, Cloud and Land Elevation satellite (ICESat) and Cosmic Hot Interstellar Spectrometer (CHIPS) satellite lifted off from Vandenberg Air Force Base, Calif., at 4:45 p.m. PST aboard Boeing's Delta II rocket. Separation of the ICESat spacecraft occurred 64 minutes after launch at 5:49 p.m. PST. Initial contact with ICESAT was made 75 minutes after launch at 6 p.m. PST as the spacecraft passed over the Svalbard Ground Station in Norway. The CHIPS spacecraft separated from the launch vehicle 83 minutes after launch at 6:08 p.m. PST. Initial contact with CHIPS was made 98 minutes after launch at

6:23 p.m. PST as the spacecraft passed over the University of California, Berkeley. ["NASA Successfully Launches the ICESat/CHIPS Satellites," **NASA News Release**, January 12, 2003.]

January 13: Space shuttle Columbia's pure science mission initially was seen as a vehicle for an all-female crew, but that idea was abandoned. Then it was proposed as a carrier for GoreSat, the Earth-observing spacecraft dreamed up by former Vice President Al Gore, but that was put on ice by a Republican Congress. After years of delays and numerous incarnations, Columbia's 16-day research flight – a rarity in that it has nothing to do with the International Space Station – is nearing liftoff under extraordinarily tight security. On board for Thursday's launch will be Israel's first astronaut, Ilan Ramon, a colonel in his country's air force and the son of a Holocaust survivor. Web posted. (2003). [Shuttle flight almost had all-female crew [Online]. Available WWW: <http://www.cnn.com/> [2003, January 13].]

◆ Hundreds of law enforcement agents are converging on Brevard County as part of growing security measures around the upcoming space shuttle mission involving an Israeli astronaut. The extraordinary precautions include everything from stepped-up patrols around Cocoa Beach and Patrick Air Force Base to dozens of SWAT team sharpshooters on rooftops. "It is for us, NASA, the dignitaries coming and the potential for a high-visibility event," said Brevard County Sheriff Phil Williams, explaining the need for heightened security. There have been no specific threats made against the shuttle or Ilan Ramon, the first Israeli astronaut to go into space. More than 200 dignitaries, including Israeli nationals, family members and other VIPs, are expected to arrive in Brevard during the next few days. Several other agencies, including the Florida Department of Law Enforcement, the FBI, NASA officials and Brevard County Fire-Rescue were also involved with arrangements. ["Hundreds of lawmen pour in for launch," **Florida Today**, January 14, 2003, p 1A & 3A.]

◆ The European Space Agency – Europe's version of NASA – has sent more than 120 scientists, engineers, contractors and technicians to Florida Institute of Technology to prepare, monitor and run 16 biology experiments scheduled to go up on Columbia. Usually, they would have packaged their experiments at home, then come to Kennedy Space Center to monitor them in space. But increased post-Sept. 11 security and increased costs of doing business at Kennedy have made the Europeans look elsewhere for a base, said Enno Brinckmann, science-experiment coordinator for ESA's microgravity and space-station-utilization department. The school was founded 40 miles from Kennedy with the intention of serving as a graduate school for NASA workers. Among the ESA experiments: research into how bone cells add or absorb calcium in microgravity; how certain infectious bacteria multiply; and the influence of microgravity on radiation damage to DNA in human cells. With a newly installed high-speed computer link between Florida Tech and Kennedy, the scientists will monitor and even control experiments onboard the shuttle, using Florida Tech's computers. ["Space research lands new home," **Orlando Sentinel**, January 14, 2003, p B1 & B7.]

January 14: Columbia is safe to fly Thursday, shuttle program manager Ron Dittmore said Tuesday. Spare parts like the cracked metal ball, which was in a support structure in a liquid fuel line, were subjected to extreme forces and temperatures. Engineers wanted to be sure the balls would still function, even if they were cracked, and that they wouldn't pose a danger to the orbiter by shedding debris. "All the evidence, all the data, all the analysis has come together," he said. "...We are very comfortable, from the bottom to the top, that we are safe to fly as is." The seven-member crew, which includes the first Israeli astronaut, is mostly relaxing, reviewing procedures and making test flights at the shuttle landing facility, Dittmore said. ["Columbia safe to fly," **Florida Today**, January 15, 2003, p 1A.]

◆ NASA Deputy Administrator Fred Gregory announced the appointment of Dr. Michael A. Greenfield as Associate Deputy Administrator for Technical Programs, effective immediately. Greenfield was formerly Deputy Associate Administrator for Safety and Mission Assurance at NASA Headquarters. In his new position, Greenfield will be the corporate and strategic advocate for NASA's technical programs and projects. ["NASA Names Associate Deputy Administrator For Technical Programs," **NASA News Release #03-012**, January 14, 2003.]

January 17: Managers today confirmed the launch of Space Shuttle Columbia for Thursday, January 16 at 10:39 a.m. EST. The launch window extends for 2 hours and 30 minutes. This announcement comes

following a final review of Shuttle processing activities and a satisfactory engineering analysis of the Ball Strut Tie Rod Assembly (BSTRA). STS-107 is a scheduled 16-day mission with a planned KSC landing at about 8:53 a.m. EST on Saturday, Feb. 1. This mission is the first Shuttle mission of 2003. Mission STS-107 is the 28th flight of the orbiter Columbia and the 113th flight overall in NASA's Space Shuttle program. ["Shuttle Mission STS-107 Launch Time Announced For Launch On Jan. 16," **NASA News Release #09-03**, January 15, 2003.]

January 16: The launch of the space shuttle Columbia – one of the highest profile flights in years – will be shrouded in security. While NASA officials admit to heightened sensitivity because of the presence of Israeli astronaut Ilan Ramon, they insist that the precautions are no greater than those taken in wake of the Sept. 11 terrorist attacks. Ramon's involvement in the 16-day research mission does present a unique threat to the shuttle, said David Saleeba, NASA's assistant administrator for security management, because of the volatile situation in the Middle East. In addition to Ramon, an Israeli delegation of about 300 is expected at KSC for the launch. The group will include the Israeli ambassador to the United States, Daniel Ayalon; the head of the country's Ministry of Science, Culture and Sport; and the director of Israel's space agency. Several former high-ranking members of the Israeli air force also are expected. NASA is relying on an assortment of agencies, both civilian and military, to safeguard the Cape for the launch. The U.S. Air Force's 45th Space Wing is patrolling the air, while the U.S. Coast Guard is scanning the water. NASA security is teaming with local and state law enforcement to watch the ground. ["Guards keep sharp eye on shuttle," **Orlando Sentinel**, January 16, 2003, p A12.]

◆ NASA managers cleared shuttle Columbia for a 10:39 a.m. launch today bearing Israel's first astronaut and a payload bay packed with science experiments. In the morning meeting, the launch team reaffirmed its decision that a cracked part inside one of shuttle Discovery's liquid fuel lines did not pose a critical threat to require inspecting similar parts buried deep in Columbia's engine compartment. NASA said the launch window stretches to 1:09 p.m. As part of heightened security since the Sept. 11 attacks, NASA keeps the precise launch time a secret until about 24 hours before liftoff. Much of the outside world's attention has been focused on Israeli Air Force Col. Ilan Ramon, who will help run some of the science experiments as his country's first spacefarer. The six other crew members are Cmdr. Rick Husband, pilot Willie McCool and astronauts Kalpana Chawla, Laurel Clark, David Brown and Michael Anderson. The flight will be devoted to scientific research, with more than 80 experiments in the shuttle's middeck and a special Spacehab research lab in the cargo bay. ["Managers give shuttle clean bill of health," **Florida Today**, January 16, 2003, p 7A.]

◆ Columbia's astronauts will be working 24 hours a day, using each other as guinea pigs in what could be the last shuttle mission focused only on life sciences. Before now, Columbia was the only shuttle incapable of flying to the International Space Station. It was qualified for science and for tasks such as refurbishing the Hubble Space Telescope. Now that the orbiter, which is scheduled to lift off between 10:39 a.m. and 1:09 p.m. today, has been modified for station missions, it makes sense to focus on biological experiments for long-duration space-station flights, said Roger Crouch, senior scientist at NASA headquarters in Washington. Columbia's mission encompasses a little bit of everything, including earth science, such as studies of the behavior of fire in space. Many experiments are concentrating on what zero gravity does to the human body. ["Flight may be last focused solely on life sciences," **Florida Today**, January 16, 2003, p 6A.]

◆ Weeks of tension and anticipation melted into relief and excitement as Columbia and a crew that includes the first Israeli astronaut soared with a roar into a bright, blue sky. Columbia embarked from Kennedy Space Center at 10:39 a.m. on a 16-day science mission. Much of the attention surrounding the oft-delayed mission focused on payload specialist Ilan Ramon. The Israel Air Force colonel is the first person from his country to fly into space. There was almost a carnival atmosphere at KSC's press site, as a number of international journalists gathered to witness the historic launch. When the astronauts' van stopped briefly outside the Vehicle Assembly Building on its way to the launch pad, one unidentified person in the Launch Control Center parking lot waved a big Israeli flag to greet them. Across the Space Coast, visitors reveled in their clear views of the launch. There were whispered prayers, loud cheers and flags bearing the Star of David waving as hundreds of people gathered at Kennedy Space Center's restricted VIP site to watch shuttle Columbia climb into the heavens. Besides Ramon, crew members are

Commander Rick Husband; pilot Willie McCool; and mission specialists Michael Anderson, David Brown, Kalpana Chawla and Laurel Clark. Once the crew settles into orbit, its seven members will be working around the clock, split into two teams on different sleep shifts. Columbia is due to land at Kennedy Space Center on Feb. 1. Web posted. (2003). [First Israeli soars into orbit [Online]. Available WWW: <http://www.floridatoday.com/> [2003, January 16]. "Pride replaces anxieties," **Florida Today**, January 17, 2003, p 1A & 3A.]

January 17: NASA's 2004 budget request, officially embargoed until President Bush presents his spending plan to Congress in February, contains a new emphasis on the nuclear propulsion research effort the U.S. space agency calls Project Prometheus, according to published report. NASA would not provide details about Project Prometheus, but NASA headquarters spokesman Don Savage said it is "in large part a renaming of part of the [Nuclear Systems Initiative] that was announced last year." NASA spokesmen Friday night questioned details revealed earlier in the day in the Los Angeles Times. The story stated that the Bush administration has given an agency the go-ahead to build a nuclear-powered rocket. Not only would the project make human travel to Mars feasible, the story suggests, work on the nuclear space rocket would be a boon to California aerospace firms. The Times reported, based on an exclusive interview with NASA chief Sean O'Keefe, the project might be announced during President Bush's State of the Union address set for Jan. 28. Savage said that the term "nuclear rocket" is not what NASA is developing. Rather, reactor technology is being pursued. ["Report: Bush supports nuke-powered rocket system," **Florida Today**, January 18, 2003, p 8A.]

January 18: Space memorabilia from the Apollo moon-landing era has become hot among collectors, and space enthusiasts now worry the items will be damaged or squirreled away in private collections, out of the reach of future generations. The U.S. government for decades has been selling off items from space missions, such as shuttle tires, unused rocket engine parts, flight manuals and maps. The feds sell the items as surplus and add the money back into agency budgets. People who pick up the items, though, often turn around and sell them through private channels. Auction houses such as Christie's and Sotheby's now hold regular auctions of space memorabilia. Online auction house eBay offers more than 2,400 space exploration collectibles. As the market heats up, some space aficionados complain items such as lunar maps and parts of space capsules have been sliced and diced, making them more lucrative sales items but wrecking their historical value. NASA "relentlessly" seeks to retain genuinely historical items, said space agency news chief Robert Mirelson. Most of the space collectibles for sale are patches, photos and other gewgaws the agency gave away by the thousands during the past four decades. ["Space sales worry buffs," **Florida Today**, January 19, 2003, p 1C.]

January 21: For the first time in 19 years, NASA is taking applications for K-12 teachers who want to ride the shuttle to space. Kicking off its Educator Astronaut program at Hardy Middle School in Washington on Tuesday. NASA said it has reserved spots for three to six adventurous teachers. Barbara Morgan, who will be the first teacher to participate in the program, is scheduled to fly on shuttle Columbia next year. She will fly as a full-fledged astronaut on a mission to the International Space Station. She also will give lessons in space. Teachers accepted in the program will be eligible to fly multiple times on the shuttle or even on a longer flight on the space station, said head astronaut Kent Rominger. ["NASA looking for teacher astronauts," **Florida Today**, January 22, 2003, p 1A & 10A.]

January 23: The science team for the Mars Exploration Rovers, set to launch from the Cape in May and June, approved two recommended landing sites this week. Gusev Crater and an area called Terra Meridiani were deemed the top two places for accomplishing the mission's scientific goals after a series of open meetings, the last of which occurred two weeks ago. Scientists hope the sites hold clues to Mars' water mystery. Those picks still have to pass several more rounds of scrutiny. A panel of experts will review the sites and make a recommendation to NASA headquarters in March. Ed Weiler, NASA's associate administrator for space science, will make the final call in April. NASA stands a mere four months away from launching the next pair of Mars rovers. ["Scientists pick sites for Mars landings," **Florida Today**, January 24, 2003, p 1A & 3A.]

January 24: Northerners may feel free to scoff, but it's a big deal here on Florida's Space Coast: Snow flurries were reported at the Kennedy Space Center Friday morning. "It's so exciting," said Linda Mullen,

a NASA employee originally from Virginia who works at the KSC Press Site. "It's itty bitty, almost like sleet that is ready to turn into snow." Attempts to capture the flurries on videotape were not successful. Web posted. (2003). [Flurries in Florida? Kennedy Space Center Gets Weird Weather [Online]. Available WWW: <http://www.space.com/> [2003, January 24].]

January 25: NASA's Solar Radiation and Climate Experiment (SORCE) successfully launched aboard a Pegasus XL rocket over the Atlantic Ocean. Dropped from the wing of an L-1011 carrier aircraft at 3:14 p.m. EST, separation of the spacecraft from the rocket occurred 10 minutes and 46 seconds after launch at about 3:24 p.m. Initial contact with the satellite was made seven seconds after separation via a NASA communications satellite network. Approximately 21 days after launch, if all is going well, the instruments will start initial science data collection and calibration will begin. The spacecraft will study the Sun's influence on our Earth and will measure from space how the Sun affects the Earth's ozone layer, atmospheric circulation, clouds and oceans. ["SORCE launch first step in study of Sun," **KSC Countdown**, January 28, 2003.]

January 27: The cruise stage, aeroshell and lander for the Mars Exploration Rover (MER-2) mission arrived Monday and have been transferred to the Payload Hazardous Servicing Facility high bay. The cruise stage and aeroshell will be removed from their shipping container on Thursday (Jan. 30). The first of the two Mars Exploration Rovers will arrive at KSC in February. ["First stages of Mars Exploration Rovers arrive at KSC," **KSC Countdown**, January 30, 2003.]

January 28: Space shuttle Columbia's astronauts joined Mission Control in a moment of silence Tuesday at the exact time 17 years ago that Challenger exploded in the sky. NASA's work force, in orbit and on Earth, remembered not only the seven astronauts who died on January 28, 1986, but also the three who were killed by a fire in their Apollo spacecraft at the pad on January 27, 1967. At the launch site Tuesday, flags flew at half staff for the second day in a row. Web posted. (2003). [Space crews remember fallen astronauts [Online]. Available WWW: <http://www.cnn.com/> [2003, January 28].]

January 29: A Boeing-built Delta 2 rocket placed the Global Positioning System satellite 800 miles above Earth after its launch at 1:06 p.m. from Cape Canaveral Air Force Station. This rocket had some problems making it to launch day. In October, a crane operator misread a technician's hand signal and pulled on the rocket's third stage while it was still attached to the second stage. This cracked a spin table between the second and third stages. The spin table helps separated the two stages in space. ["Delta 2 replaces military satellite," **Florida Today**, January 30, 2003, p 1A.]

January 30: The General Accounting Office reported Thursday that NASA has made significant progress toward solving management problems in the past two years, but there are still areas of concern. The GAO applauded the National Aeronautics and Space Administration's efforts to bring the international space station program under budgetary control and said the agency has a strong plan in place to replace its aging work force. But NASA still needs to improve how it manages its work force and make sure the space station meets a new set of financial targets, the report by the investigative arm of Congress said. The agency needs to keep trying to cut the cost of launches – including the space shuttle – and clean up its system of overseeing contracts with private companies. The GAO tapped NASA's contract management as "high-risk" because of past problems. NASA, however, is bringing on board an agency-wide accounting system that should help, the report said. NASA spokesman Robert Mirelson said the agency is pleased the GAO noted its efforts to improve and that more progress is coming. ["NASA, HUD solve some of their problems, GAO report says," **Orlando Sentinel**, January 31, 2003, p A10.]

January 31: NASA has settled negotiations that increase the value of a two-year extension of the Space Flight Operations Contract (SFOC) held by United Space Alliance, LLC, in Houston, by \$59.91 million. NASA's exercising of the two-year SFOC extension, which supports the Space Shuttle Program, was previously announced in August 2002 with negotiations continuing. This final agreement on price, terms, conditions and scope of work for the contract, through Sept. 30, 2004, brings the total value of the two-year contract extension to \$2.90 billion. The SFOC is NASA's prime contract for support of the Space Shuttle and provides operations services for the International Space Station. The effort under this contract entails the provision of space flight operations including all work necessary and appropriate to support scheduled

space flight missions through the two-year period. This is a cost reimbursement contract with award fee, incentive fee and performance fees. The principal places of performance of work under this contract are United Space Alliance facilities in Houston, Huntsville, Ala., the Kennedy Space Center, Fla., and major subcontractor facilities in Huntington Beach, Calif., Houston, and Cape Canaveral, Fla. ["NASA Finalizes Contract With United Space Alliance," **NASA News Release #C03-001**, January 31, 2003.]

◆ Good weather is expected for the landing of the shuttle Columbia Friday (Feb. 1) at Kennedy Space Center. The orbiter's first landing attempt is at 9:15 a.m. Scattered clouds and favorable winds are forecast for the end of the 16-day science mission. If the first attempt is waved off, a second attempt is scheduled for 10:51 a.m. Apparent minor damage to the protective tiles on Columbia's left wing shouldn't affect the procedure for landing, entry flight director Leroy Cain said Friday (Jan. 31). The damage was likely caused by foam that came off the shuttle's external tank during ascent, a Johnson Space Center spokesman said. ["Forecast shows good landing weather," **Florida Today**, February 1, 2003, p 1B.]

◆ The launch of a Titan 4B rocket scheduled for next week at Cape Canaveral Air Force Station has been pushed back until March at the earliest. It is supposed to carry a Milstar military communications satellite into orbit. Mission managers were afraid that part of the rocket might swing too much when the Centaur upper stage engine fired. The Eastern Launch and Test Range will undergo an upgrade from Feb. 10 to March 4. This is the system that helps track and communicate with the rocket. The booster will be rescheduled after the range reopens. The Delta 4, also scheduled to launch next week with a DSCS military communications satellite, has been delayed a day to Feb. 7 at the earliest. Launch time is about 7:06 p.m. to 11 p.m. ["Titan 4B launch postponed," **Florida Today**, February 1, 2003, p 1B.]

During January: Nelson Engineering Co., headquartered in Titusville, recently was awarded Kennedy Space Center's Small Business Subcontractor of the Year award for fiscal year 2002. The company began operations in May 1993 and provides a wide range of engineering services to the aerospace community. Current subcontractors include Space Gateway Support, United Space Alliance, Boeing and Lockheed Martin. ["KSC names local company as Small Business Subcontractor of the Year," **Brevard Technical Journal**, January 2003, p 14.]



The STS-107 crew poses in front of the entry into Space Shuttle Columbia during Terminal Countdown Demonstration Test activities on the pad. Kneeling in front are (left to right) Payload Specialist Ilan Ramon (the first Israeli astronaut), Pilot William "Willie" McCool and Mission Specialist David Brown. Standing in back are (left to right) Payload Commander Michael Anderson, Mission Specialist Kalpana Chawla, Commander Rick Husband and Mission Specialist Laurel Clark. The TCDT also includes a simulated launch countdown. STS-107 is a mission devoted to research and will include more than 80 experiments that will study Earth and space science, advanced technology development, and astronaut health and safety.

FEBRUARY

February 1: (9:20 a.m.) NASA has lost communication with the orbiter Columbia and has no tracking data. (9:39 a.m.) Kennedy Space Center is locked down with security. (9:43 a.m.) TV stations are reporting Columbia exploded over Texas with debris falling over Texas. (10:55 a.m.) NASA ordered contractor to close the Kennedy Space Center Visitors Complex. (12:06 a.m.) Twenty five Kennedy Space Center staff are on their way to Texas to assist with the search and rescue. Also, the Defense Department has dispatched a team of people who specialize in space shuttle support. Web posted. (2003). [STS-107 Columbia landing journal [Online]. Available WWW: <http://www.floridatoday.com/> [2003, February 1].]

(12:09 p.m.) A Space Shuttle contingency has been declared in Mission Control, Houston, as a result of the loss of communication with the Space Shuttle Columbia at approximately 9 a.m. EST Saturday as it descended toward a landing at the Kennedy Space Center. It was scheduled to touchdown at 9:16 a.m. EST. Communication and tracking of the shuttle was lost at 9 a.m. EST at an altitude of about 203,000 feet in the area above north central Texas. At the time communications were lost, the shuttle was traveling approximately 12,500 miles per hour (Mach 18). No communication and tracking information were received in Mission Control after that time. Search and rescue teams in the Dallas-Fort Worth and in portions of East Texas have been alerted. Flight controllers in Mission Control have secured all information, notes and data pertinent to today's entry and landing by Space Shuttle Columbia. ["NASA Statement on Loss of Communications With Columbia," **NASA News Release #03-030**, February 1, 2003.]

(1:32 p.m.) NASA says it's clear there are no survivors. Associate Administrator Bill Readdy, a former astronaut himself: "Sadly, I think from the video that is available, it does not appear there were any survivors." Web posted. (2003). [STS-107 Columbia landing journal [Online]. Available WWW: <http://www.floridatoday.com/> [2003, February 1].]

(2:05 p.m.) "My fellow Americans, this day has brought terrible news and great sadness to our country. At 9:00 a.m. this morning, Mission Control in Houston lost contact with our space shuttle Columbia. A short time later, debris was seen falling from the skies above Texas. The Columbia is lost; there are no survivors.," President Bush tells the nation. "May God bless the grieving families, and may God continue to bless America." Web posted. (2003). [Text of Bush's statement on Columbia [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, February 1].]

(4 p.m.) Shuttle program manager Ron Dittmore, in an emotional briefing with his top technical deputies, says point blank that NASA does not know what happened yet. He says the agency needs to reconstruct as much of the vehicle as possible. He thanks the public for its aid in finding debris, which is spread over a large area. Web posted. (2003). [STS-107 Columbia landing journal [Online]. Available WWW: <http://www.floridatoday.com/> [2003, February 1].]

(4 p.m.) Statement by NASA Administrator Sean O'Keefe: "This is indeed a tragic day for the NASA family, for the families of the astronauts who flew on STS-107, and likewise is tragic for the Nation. Immediately upon indication of a loss of communications from STS-107, at a little after 9:00 a.m. this morning, we began our contingency plan to preserve all the information relative to the flight activities. I immediately advised the President and the Secretary of Homeland Security, Tom Ridge, at the point after landing was due to have occurred at 9:16 a.m., and spoke to them very briefly to advise them that we had lost contact with the Shuttle orbiter, Columbia, and STS-107 crew. They offered, the President specifically offered, full and immediate support to determine the appropriate steps to be taken. We then spent the next hour and a half working through the details and information of what we have received and Bill Readdy, Associate Administrator for the NASA Office of Space Flight, will walk you through the specifics of those operational and technical issues. We met with the family members of the astronauts who were here at the Kennedy Space Center and are soon to be departing back to the Johnson Space Center in Houston. The President has called and spoken to the family members to express our deepest national regrets. We have assured them that we will begin the process immediately to recover their loved ones and understand the cause of this tragedy. We have no indication that the mishap was caused by anything or anyone on the

ground. We assembled a Mishap Investigation Team at a point past the stage that the orbiter was to have landed here at Kennedy Space Center a little after 9:30. That team, in turn, is coordinating on a regular basis on all the facts that are pertaining to this from the Johnson Space Center with help from a Rapid Response Team from here at the Kennedy Space Center, as well participants from the Marshall Space Flight Center in Huntsville, Alabama. In addition to these internal efforts, we have appointed a Mishap Investigation Board, an external group of people who are independent from NASA who will be charged with the responsibility to look at all the information that was immediately locked down right after the absence of communications. Each of these individuals are Safety and Mission Assurance related officials in other departments of the Federal government, from the Air Force, the Navy, the Department of Transportation, and across the federal expanse. This Investigation Team will be chaired by an individual who is external to the federal agencies and will have the responsibility to coordinate all the information from an external view. So we'll be conducting both the internal activity as well as the external review immediately to ascertain the causes and circumstances under which this tragedy occurred. We have pulled together all the federal agencies and local governments as well. I have been in discussion several times this morning with Secretary Tom Ridge. The effort is under way to coordinate an understanding of exactly where the orbiter path had taken it from West Texas towards the Kennedy Space Center here in Florida and to make sure that the material on the ground is secured so that the investigation can begin promptly. We would urge people who believe they have found any material to stay away from it and to please contact local officials. The local first responder groups for emergency services have been authorized and directed by Secretary Tom Ridge to assist in any way. The Federal Emergency Management Agency is coordinating that effort on behalf of the Department of Homeland Security. I was here this morning with the families of the astronauts and their friends. It started out as a pretty happy morning, as we awaited the landing of STS-107. We had highly anticipated their return because we couldn't wait to congratulate them for their extraordinary performance and their excellent effort on this very important science mission. They dedicated their lives to pushing scientific challenges for all of us here on Earth. They dedicated themselves to that objective and did it with a happy heart, willingly and with great enthusiasm. The loss of this valued crew is something we will never be able to get over. We have assured the families that we will do everything, everything we can possibly do to guarantee that we work our way through this horrific tragedy. We ask the members of the media to honor that too. Please respect their privacy and please understand the tragedy that they are going through at this time. We will help the media assure that this will be the case as well. We trust the prayers of the Nation will be with them and with their families. A more courageous group of people you could not have hoped to know- an extraordinary group of astronauts who gave their lives-and the families of these crewmembers. They knew exactly the risks. And never, ever did we want to see a circumstance in which this could happen. We diligently dedicate ourselves every single day to assuring these things don't occur. And when they do we have to act responsibly, accountably and that is exactly what we will do." ["Statement by NASA Administrator Sean O'Keefe," **NASA News Release #03-032**, February 1, 2003.]

(5 p.m.) NASA has established a telephone hotline and electronic mail address for the public to use for reporting information that may help investigators studying today's Space Shuttle mishap. Anyone who discovers debris from the accident or who has film or video evidence that may be of value to the investigation team is urged to use these contacts. Please avoid contact with any debris, because it may be hazardous as a result of toxic propellants aboard the Shuttle. All debris is U.S. Government property and is critical to the investigation of the mishap. All debris from the accident is to be left alone and reported to Government authorities. Unauthorized persons found in possession of accident debris will be prosecuted to the full extent of the law. ["NASA Asks For Help With Columbia Investigation," **NASA News Release #03-033**, February 1, 2003.]

(7:00 p.m.) The Space Shuttle Columbia and its seven astronauts were lost today when the vehicle broke up over north central Texas during its reentry from orbit. Communications were lost with Columbia and its crew at around 8:00 a.m. CST, while the shuttle was traveling about 18 times the speed of sound at an altitude of 207,000 feet. Columbia was 16 minutes from landing at the Kennedy Space Center when flight controllers at Mission Control lost contact with the vehicle. Columbia was returning from a 16-day scientific research mission, its 28th flight, which launched on January 16. Aboard Columbia were Commander Rick Husband, completing his second flight, Pilot William McCool, wrapping up his first mission, Mission Specialists Dave Brown, also completing his first mission, Kalpana Chawla, on her

second flight, Laurel Clark, a first-time space traveler, Payload Commander Mike Anderson, ending his second flight, and Payload Specialist Ilan Ramon of the Israel Space Agency, on his first flight. Prior to the loss of communications with Columbia, the shuttle's return to Earth appeared perfectly normal. After assessing some wispy fog near the shuttle's three-mile long landing strip at KSC before dawn, Entry Flight Director Leroy Cain gave approval for the firing of the shuttle's braking rockets to begin its descent from orbit. Husband and McCool began the deorbit burn to allow Columbia to slip out of orbit at 7:15 a.m. CST. There was no indication of anything abnormal with Columbia's reentry until the last communications between Mission Control and the crew. At Columbia's intended landing site, NASA Administrator Sean O'Keefe and Associate Administrator for Space Flight William Readdy met with the families of the astronauts to offer their condolences, vowed to uncover the cause of the accident and press ahead with the Shuttle program. "This is indeed a tragic day for the NASA family, for the families of the astronauts who flew on STS-107, and likewise is tragic for the nation," said O'Keefe. "We have no indication that the mishap was caused by anything or anyone on the ground," O'Keefe added. In a briefing, Chief Flight Director Milt Heflin said that around 7:53 a.m. CST, just minutes before communications were lost with Columbia, flight controllers detected indications of a loss of hydraulic system temperature measurements associated with Columbia's left wing, followed three minutes later by an increase in temperatures on the left main gear tires and brakes. At 7:58 a.m., flight controllers noted a loss of bondline temperature sensor data in the area of the left wing followed a minute later by a loss of data on tire temperatures and pressures for the left inboard and outboard tires. After several attempts to try to contact Columbia, Cain declared a contingency, whereby flight controllers began preserving documentation regarding the entry phase of the flight. Recovery forces fanned out from Texas to Louisiana to try to recover debris that will be pertinent to the mishap investigation. Space Shuttle Program Manager Ron Dittmore said several teams have been organized to gather data for analysis and will report to an external investigation board that was appointed by Administrator O'Keefe. Dittmore added that no specific orbiter debris or crew remains have been positively identified at this time, and that there is no leading theory for the cause of the accident. Dittmore said the processing of other shuttles at the Kennedy Space Center for future launches has been temporarily halted to enable engineers to review data regarding vehicle processing and to focus attention on capturing all pertinent information involving Columbia's prelaunch preparations. NASA managers will be meeting on a regular basis to begin reviewing data associated with Columbia's investigation. The next status briefing from the Johnson Space Center is tentatively scheduled from the Johnson Space Center, Houston, TX at 12:00 p.m. CST Sunday. On the International Space Station, Expedition 6 Commander Ken Bowersox, Flight Engineer Nikolai Budarin and NASA ISS Science Officer Don Pettit were informed of the loss of Columbia and its crew shortly after a Russian Progress resupply vehicle undocked from the ISS. Filled with discarded items no longer needed on the ISS, the Progress was commanded to deorbit by Russian flight controllers and reentered the Earth's atmosphere. A new Progress cargo ship will be launched Sunday from the Baikonur Cosmodrome in Kazakhstan at 6:59 a.m. CST (1259 GMT) filled with supplies for the Expedition 6 crew. It is scheduled to dock to the ISS Tuesday morning. ISS program officials say, if necessary, the current resident crew could remain in orbit until late June with the supplies being ferried to the station on the new Progress. [STS-107 MCC Status Report #19, February 1, 2003.]

◆ Statement on STS-107 by the United Space Alliance: "We deeply regret today's tragedy, and our hearts and prayers go out to the families of the crew. The safety of the astronauts has always been our top priority, and this tragic loss is very painful to us all. Right now, our top priority is and will remain the determination of the cause of the accident as soon as possible in order to prevent it from ever happening again." Signed: Russell D. Turner, President and CEO, United Space Alliance. Web posted. (2003). [Statement on STS-107 by the United Space Alliance [Online]. Available WWW: <http://www.spaceref.com/> [2003, February 1].]

◆ NASA investigators Saturday began looking at a complex series of events seconds after the launch of shuttle Columbia that may have doomed the ship and its seven-member crew. Much of their attention focused on the spaceship's left wing. Seconds after the shuttle's Jan. 16 liftoff, a chunk of rubbery insulation from Columbia's external fuel tank broke loose and struck the wing's heat-resistant tiles that protect the ship from temperatures of up to 3,000 degrees Fahrenheit during its fiery return to Earth. Flight controllers stopped receiving temperature data from sensors on the wing's hydraulic system, landing-wheel well and trailing edge just minutes before the shuttle disintegrated over east central Texas on Saturday. Even so, NASA chief flight director Milt Heflin warned it is too soon to blame the tank debris for the

disaster. ["Fatal return, a stunned NASA searches for answers," Orlando Sentinel, February 2, 2003, p 1 & 22.]

◆ Federal officials began combing through the rural landscape of eastern Texas and western Louisiana after pieces of Columbia littered fields and peppered buildings across more than 500 square miles. The Environmental Protection Agency began coordinating a massive cleanup, and the Army's 1st Cavalry Division deployed a task force – including helicopters and military police – to help search for wreckage from the 17,800 pound shuttle. Local, state and federal authorities joined in to search for clues to the national tragedy. Authorities ordered people to stay at least 100 yards away from the debris because of contamination fears, but a number of residents picked up pieces and turned them over to police. The epicenter of the fallout appeared to be Nacogdoches, which is about 145 miles northeast of Houston. Parts were also scattered across western Louisiana, including some pieces that apparently plunged into Toledo Bend reservoir on the Texas border. Two F-16s from the Naval Air Station Joint Reserve Base in Fort Worth were dispatched to help map the debris field. ["Sky lights up, and rain of metal starts," Orlando Sentinel, February 2, 2003, p 2-3.]

◆ The space shuttle Columbia carried a variety of chemicals that could cause serious problems – from burns to respiratory illnesses – for anyone who touches them. Officials said most of the chemicals would have quickly dissipated after the Columbia accident, but traces could remain on pieces of tanks in which they were contained or on maneuvering thrusters. "The danger is if there happens to be something still on the ground contained in a container," said Bruce Buckingham, spokesman for Kennedy Space Center. Monomethyl hydrazine and nitrogen tetroxide are the two chemicals primarily used as rocket fuel, igniting upon contact in the shuttle. Officials weren't sure how much of the fuels were left in reserves when the Columbia began breaking apart, and it was uncertain what kind of shape the containers would be in after crashing to Earth. ["Debris could harbor dangerous residue," Orlando Sentinel, February 2, 2003, p 5.]

◆ Hours after Columbia took to the skies on Jan. 16, NASA administrators knew that critical thermal tiles on the shuttle's left wing might have been damaged. For almost two weeks, they pondered the impact of the damage – knowing full well there was nothing they could do if it turned out to be serious. They reviewed video footage of the launch, showing a piece of insulating foam falling from the external fuel tank and striking Columbia's left wing. On Friday, reflecting what officials said was a unanimous view, NASA's lead flight director, Leroy Cain, said engineers had concluded that any damage to the wing would not be a safety hazard. On Saturday – after Columbia disintegrated over Texas minutes after sensors on the left wing stopped functioning – administrators were second-guessing themselves. "We can't discount that there might be a connection," shuttle manager Ron Dittmore said during an emotional press conference. Dittmore said the astronauts had no ability to inspect the underside of the shuttle, where the tile damage may have occurred, or to attempt a spacewalk to fix it. In fact, tile damage is nothing new, the shuttle Discovery landed in 1985 with 123 badly damaged tiles, a success that engineers called a tribute to the shuttle's design. "We have no capability to repair it," Dittmore said. "All we can do is, before we launch, design robustness into the system so that a loss of some tile capability will not result in loss of crew or vehicle." ["NASA suspected after liftoff that something was wrong," Orlando Sentinel, February 2, 2003, p 22.]

February 2: NASA Administrator Sean O'Keefe today announced the members of the Space Shuttle Mishap Interagency Investigation Board, which will provide an independent review of the events and activities that lead up to the tragic loss of the seven astronauts Saturday on board the Space Shuttle Columbia. Retired U.S. Navy Admiral Harold W. Gehman, Jr., will chair the panel. Other members of the investigative board includes: Rear Admiral Stephen Turcotte, Commander, U.S. Naval Safety Center, Norfolk, Va.; Major General John L. Barry, Director, Plans and Programs, Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio; Major General Kenneth W. Hess, Commander, U.S. Air Force Chief of Safety, Kirtland Air Force Base, N.M.; Dr. James N. Hallock, Aviation Safety Division Chief, U.S. Department of Transportation, Cambridge, Mass.; Steven B. Wallace, Director of Accident Investigation, Federal Aviation Administration, Washington; Brigadier General Duane Deal, Commander 21st Space Wing, Peterson Air Force Base, Colo. Several senior NASA leaders also will be a part of the panel, including G. Scott Hubbard, Director, NASA Ames Research Center, Moffett Field, Calif.; Bryan D.

O'Connor, NASA Associate Administrator and former astronaut, Office of Safety and Mission Assurance, Headquarters, will serve as Ex-Officio Member; and Theron Bradley, Jr., NASA Chief Engineer, NASA Headquarters, Washington, will be Executive Secretary. ["NASA Announces Space Shuttle Columbia Accident Investigation Board (The Gehman Board)," **NASA News Release #03-034**, February 2, 2003.]

◆ The President and Mrs. George W. Bush will join NASA Administrator Sean O'Keefe Tuesday (February 4) afternoon in paying tribute to the brave heroes of the Space Shuttle Columbia crew during a special memorial service at the NASA Johnson Space Center in Houston. The ceremony will honor NASA astronauts Rick Husband, William McCool, Michael Anderson, Kalpana Chawla, David Brown, Laurel Clark, and Israeli astronaut Ilan Ramon. This will be a private ceremony for family members, friends, and invited guests, along with NASA employees and contractors. ["NASA Memorial Service Scheduled At Johnson Space Center," **NASA News Release #03-37**, February 2, 2003.]

◆ Two briefings are scheduled Monday (February 3) in NASA's continuing effort to keep the public up-to-date on the latest developments involving the investigation into the tragic accident that killed the seven-member crew of Space Shuttle Columbia. Both briefings will feature questions from reporters at participating NASA centers and will be broadcast live on NASA Television. ["NASA Asks For Help With Columbia Investigation," **NASA News Release #03-033**, February 2, 2003.]

◆ Insurers will soon be processing a claim for the commercial research laboratory that was lost aboard the shuttle Columbia. The claim will be filed by Spacehab Inc., of Webster, Tex., a company that has built its business around NASA's space shuttle program. Columbia's 16-day research mission marked the debut of the Research Double Module, a pressurized science lab installed in the shuttle's cargo bay. The module was designed, built, owned and operated by Spacehab. The reported value of the Double Research Module is roughly equivalent to the company's \$100 million in annual revenue. Web posted. (2003). [\$100 Million Commercial Science Lab Lost on Columbia Was Insured [Online]. Available WWW: <http://www.space.com/> [2003, February 2].]

◆ United Space Alliance (USA), operator of NASA's space shuttle fleet, is continuing to prepare the shuttle Endeavour for its next flight despite the disruption to normal shuttle operations caused by Saturday's loss of Columbia, said Mike Curie, a spokesman for USA. USA, which is jointly owned by Boeing Co. of Chicago and Lockheed Martin Corp. of Bethesda, Md., also is continuing previously scheduled maintenance work on the shuttle Discovery and does not expect that effort to be slowed in the aftermath of the accident, Curie said Feb. 2. "We've been instructed by NASA to continue processing Endeavour for its next flight, whenever that may be," he said. USA is following a pre-determined contingency plan as it reacts to the tragic loss of Columbia Saturday morning in the skies over Texas. Curie said the company's employees in Houston and at the Kennedy Space Center in Florida were told to impound flight data and hardware related to the lost orbiter so it can be safeguarded and centralized for investigators probing the accident. He said USA routinely keeps information and other material following each shuttle launch, but is taking extra steps to ensure the integrity and availability of anything connected with the last flight of Columbia. Web posted. (2003). [Shuttle Endeavour Flight Preparations Continue [Online]. Available WWW: <http://www.space.com/> [2003, February 2].]

◆ The three-man crew at the International Space Station was grieving but still proud to be on its mission after being told about the Columbia accident by a NASA official. Bob Cabana, director of flight crew operations, said he told the crew of two American's and one Russian about the accident roughly 24 hours after Columbia disintegrated 39 miles over Texas. The latest crew – NASA astronauts Ken Bowersox and Don Pettit and Russian Soyuz commander Nikolai Budarin – arrived at the space station in November and is scheduled to return to Earth in March. Cabana said he assured Bowersox that he would tell the crew anything learned from the Columbia investigation. He also shared stories about Columbia's crew. Web posted. (2003). [Space Station Crew Grieves for Lost Comrades, Soldiers On [Online]. Available WWW: <http://www.space.com/> [2003, February 2].]

◆ The space shuttle Columbia, lost with its seven-person crew in a re-entry accident on Saturday, was considered for retirement in 2001. The oldest orbiter in the fleet, it had experienced engineering problems

before during a long career that began with the first shuttle mission more than 20 years ago. Yet none of the previous glitches on Columbia, which underwent a \$90 million, 17-month overhaul that began in September 1999, were thought to have contributed to the fatal mishap. The 90-ton shuttle, heavier than other spacecraft in the fleet, was the only one not outfitted to dock with the international space station. NASA had considered mothballing it in 2001 because of budget constraints, but decided to keep it in service, in part to ensure flying several scheduled missions. The \$2 billion craft has been part of numerous NASA milestones since becoming the first shuttle to go into orbit in 1981. Web posted. (2003). [NASA weighed retiring Columbia in 2001 [Online]. Available WWW: <http://www.cnn.com/> [2003, February 2].]

◆ The external fuel tank that launched the space shuttle Columbia – a focus of the investigation into Saturday's disaster – was a type that was being phased out and used insulation that had flaked off on a prior mission. But Lockheed Martin, which operates the facility that has made the external fuel tanks for every shuttle flight, said the tank used on Columbia's fatal flight was "perfect for this mission." NASA chief Sean O'Keefe said Sunday that investigators will examine whether insulation that broke from the tank during its Jan. 16 launch damaged heat-protecting tiles and ultimately doomed the shuttle and its seven astronauts. Before the shuttle broke apart, NASA had determined that Columbia was not damaged when the insulation broke off and struck the shuttle's left wing. The Lockheed Martin Michoud Assembly Center in New Orleans produces the shuttle program's 154-foot-high external tanks, which are used only once. Columbia's final mission used a "lightweight tank," a type first used in April 1983 by the space shuttle Challenger. Web posted. (2003). [External tank one focus of Columbia investigation [Online]. Available WWW: <http://www.cnn.com/> [2003, February 2].]

◆ Statement from eBay: eBay and its community of users are deeply saddened by the loss of the Space Shuttle Columbia and its brave crew. Our sympathies go out to the families of the crew and all those affected by this terrible tragedy. The handling of any debris from the Space Shuttle Columbia is potentially dangerous and against Federal law. Any listing of shuttle debris on eBay, now or in the future, will be immediately removed from the site. In addition, eBay will cooperate fully with law enforcement agencies requesting information about users attempting to list illegal items. Web posted. (2003). [eBay press statement – Space Shuttle Columbia Tragedy [Online]. Available WWW: <http://www.spaceref.com/> [2003, February 2].]

◆ NASA is centering a series of failures in shuttle Columbia's left wing because temperatures just above the wing and beneath it spiked in the seconds before NASA lost contact with the ship. Columbia disintegrated over Texas on Saturday as it attempted to re-enter Earth's atmosphere. The investigation of the crash began to take shape Sunday as members of a NASA mishap team and newly appointed independent review board began arriving at Barksdale Air Force Base near Shreveport, La., where pieces of the shuttle began arriving from scattered locations across Texas and Louisiana. Meanwhile, NASA's engineers scoured bits of data the shuttle transmitted to the ground during its final minutes flying across the western United States and found further indications that its thermal-protection systems failed. Temperatures outside and above the left wing rose 60 degrees in about five minutes. At the same time, without warning, ground computers stopped getting readings from temperature instruments inside the left wheel well. Another temperature indicator showed the heat outside the left side of the orbiter was spiking as it flew over California. Shuttle Program Manager Ron Dittemore said the vehicle was pulling to the left and its automated flight control computer tried to correct the vehicle's position. The data indicates the automatic pilot was correcting more severely than it ever had in any of the previous 112 flights of the space shuttles. The cause of the increasing temperatures on the left side of the shuttle is not known, but NASA continues to study an incident 80 seconds into the launch of Columbia on January 16 from KSC. ["NASA scours data," **Florida Today**, February 3, 2003, p 1S & 2S.]

◆ Experts at Kennedy Space Center are sifting through information that may help the Columbia accident investigation. "We've impounded all the data, and we've moved it to a retention center here at KSC," said Jack King of United Space Alliance, the company that processes shuttles at KSC. Kennedy Space Center provided all of its film of the launch to the investigation, NASA spokesman Bruce Buckingham said Sunday. It will help in the analysis of the piece of foam that flew off the external tank and hit the orbiter's left wing. "Today, we've got 20 different teams operating, with six members on each team, and it's broken down by subsystem," King said. The teams consist of specialists in such areas as hydraulics and insulating

tiles. They are looking at information dating from when Columbia came back from its last mission – the Hubble telescope repair mission in March 2002 – through launch. Normal shuttle processing is continuing for Discovery, which is undergoing an overhaul, and Endeavour, King said. Atlantis is in the Vehicle Assembly Building, mated to the boosters and external tank, awaiting a test before its planned rollout. USA employees who are specialists on Spacehab are at Barksdale Air Force Base in Louisiana to aid in identifying debris, King said. Fifty more USA workers were on standby to join the recovery effort. [“Shuttle component experts sifting through data at KSC,” **Florida Today**, February 3, 2002, p 4S.]

◆ When astronauts on shuttle Columbia granted early morning interviews from space a few days ago, only a few journalists took advantage of the opportunity and showed up at Kennedy Space Center. And for Saturday’s scheduled landing of the space shuttle, relatively few reporters were at the space center. But shortly after the accident over Texas, news crews began pouring into KSC and, by Sunday morning, news media had reached levels not seen since John Glenn’s return to space a few years ago and the Challenger accident 17 years ago. “Typically on a landing we’re going to get about 100 (news crews) or less,” said Bruce Buckingham, a spokesman for KSC. “Now we probably have 10 times that much.” During the busiest period Saturday afternoon, employees at the center were handling more requests for journalists’ credentials than they had in a long time. Journalists came from news organizations from around the world. Many more are in Houston. Trucks with satellite dishes, and other vehicles packed the parking lot at the press site. [“News media crowd covers space center,” **Florida Today**, February 3, 2003, p 6S.]

◆ Visitors to Kennedy Space Center’s Visitor Complex dropped assorted flowers at the Astronaut Memorial. Seventeen astronauts are memorialized on the Space Mirror located at the Visitor Complex. The memorial is designed to perpetually shine light through the names that have been carved all the way through slabs of granite. Those names include astronauts from Challenger and Apollo 1, but also others who died in training accidents. As for adding the names of the Columbia’s crew, Steve Feldman, president of the Astronauts Memorial Foundation, said it is premature to talk of such things. “We’re mourning the loss of Columbia. People are either grieving or praying,” he said Saturday, as he was about to attend a silent vigil at the memorial. [“Too early to add names to astronauts memorial,” **Florida Today**, February 3, 2003, p12S.]

February 3: Vice-President Richard (Dick) B. Cheney will join NASA Administrator Sean O’Keefe Thursday, February 6, at the Washington National Cathedral for a private memorial service to honor the dedicated and brave crew of the Space Shuttle Columbia. [“Vice-President to honor Columbia’s crew at National Cathedral,” **NASA News Release #03-045**, February 3, 2003.]

◆ Statement from the families of the Space Shuttle Columbia: On January 16th, we saw our loved ones launch into a brilliant, cloud-free sky. Their hearts were full of enthusiasm, pride in country, faith in their God, and a willingness to accept risk in the pursuit of knowledge --- knowledge that might improve the quality of life for all mankind. Columbia’s 16-day mission of scientific discovery was a great success, cut short by mere minutes ---- yet it will live on forever in our memories. We want to thank the NASA family and people from around the world for their incredible outpouring of love and support. Although we grieve deeply, as do the families of Apollo 1 and Challenger before us, the bold exploration of space must go on. Once the root cause of this tragedy is found and corrected, the legacy of Columbia must carry on --- for the benefit of our children and yours. [“Statement from the families of Space Shuttle Columbia,” **NASA News Release #03-043**, February 3, 2003.]

◆ A few days before the Columbia shuttle disaster, NASA noted that debris that hit the left wing during takeoff created “the potential for a large damage area to the tile.” In the internal memo, the space agency said the incident should have “no mission impact.” But now, NASA says, “it may certainly be the leading candidate” in the search to explain the shuttle’s breakup during re-entry Saturday. The memo was written twelve days into Columbia’s mission by the manager of the mission evaluation room (MER), where engineers monitor components of the orbiter during shuttle flights. The memo said analyses indicate “possible localized structural damage but no burn-through, and no safety of flight issue” from the insulation that fell off an external fuel tank when Columbia blasted off. The memo was written by Don L. McCormack, Jr., STS-107 Lead MER Manager. Web posted. (2003). [NASA memo warned of ‘potential for large damage,’ [Online]. Available WWW: <http://www.cnn.com/> [2003, February 3].]

◆ At a briefing to KSC employees, Center Director Roy Bridges shared these thoughts: “[They are] seven heroes we regarded as our KSC family members. Today as we pause from our tasks, let us reflect and remember, let us count the many blessings... in the honor we have had knowing and working with these astronauts in our joint effort to explore space. Let us each take comfort in this thought, that we each had the freedom to choose to work in the space program... That we each regard it as a special privilege to be a member of this team of like-minded people... That we do it in a spirit of awe and wonder and joy for the benefit of all on this planet. We are a people who live to explore. We count the risk and we still choose to do it because the results are worth it. This is the best team on this planet and don’t you ever forget that... We must avoid ever losing faith in each other. We should not feel guilty about the feeling of exhilaration on [the expected] return of the crew of Columbia. Remember them by getting on with the mission to explore space.” [“Fallen heroes evoke messages of faith, tribute and support,” **KSC Countdown**, February 4, 2003.]

◆ NASA revealed Monday that some engineers have dissented all along from the official conclusion that shuttle Columbia was not severely damaged by a chunk of insulation during liftoff Jan. 16. Shuttle-program director Ron Dittmore said he only now has become aware of the internal disagreements, which he credited with forcing NASA investigators to reassess all assumptions about the cause of the disaster. Until Monday, Dittmore had repeatedly asserted that program managers and engineers had “agreed to a person” that damage to the left wing from the flying debris was “inconsequential.” But on Monday, he conceded, “Certainly the debris is one of our primary areas of emphasis.” The reason, he said, is that some lower-level engineers are – and have been – questioning the assumption that the impact of the insulation was essentially harmless. Dittmore said he became aware of their concerns only recently – not during Columbia’s 16-day mission when scientists repeatedly discussed the insulation, which appeared to explode into a mist upon contact with the shuttle. He did not reveal details of the internal disagreements. [“Engineers disagreed on damage, NASA says,” **Orlando Sentinel**, February 4, 2003, p A1 & A10.]

◆ As tragic as the Columbia disaster is, it could have been much worse if debris had rained down on the Dallas area, with its 3.5 million people, or some other heavily populated area in the shuttle’s path. Instead, the majority of the pieces fell onto sparsely populated Nacogdoches county – population 59,000. But while President Bush and NASA Administrator Sean O’Keefe expressed amazement that no one was struck by debris, the thanks goes more to the prevailing winds and pure luck than any carefully planned NASA trajectory. Until Saturday, very few people worried about the dangers a disaster on re-entry might pose to those below. In Brevard County, officials are always “aware” that the shuttle is returning, but there’s no specific plan for what to do if it crashes. [“Officials didn’t have debris plan,” **Orlando Sentinel**, February 4, 2003, p A4.]

◆ On their first day back to work after the Columbia disaster, many residents of Florida’s space coast sought comfort in the rhythm of typical life. From NASA engineers to local coffee-shop servers, they set their resolve on doing the work that keeps this community going. At Kennedy Space Center, NASA brought in 30 grief counselors to comfort the nearly 16,000 engineers, technicians and others for whom shock was just starting to wear off, said Bruce Buckingham, an agency spokesman. “We’ve had Columbia here since 1979. It’s more than an old car to us,” Busckingham said. “People have spent their entire careers working on Columbia. Now they have to do something else.” Officials at the space center also started planning for a Friday memorial service and held a closed-door meeting to boost worker’s morale. Hundreds of NASA workers attended, others watched on a closed-circuit television. [“NASA’s workers aim to carry on,” **Orlando Sentinel**, February 4, 2003, p A7.]

◆ The NASA engineer credited with writing a sharply critical 1997 report about damage to heat-resistant tiles on the space shuttle Columbia said Monday that the report had actually been ghost-written by another NASA writer. But Greg Katnik, a shuttle engineer who led the team that inspected the Columbia in December 1997, stood by the accuracy of the report. The report said more than 300 of the shuttle’s fragile tiles had been damaged by foam insulation that fell off its external fuel tank during liftoff from Kennedy Space Center. The report, which summarized a formal 76-page inspection analysis that Katnik had submitted to NASA, also said that more than 100 of Columbia’s tiles had to be replaced and called the damage to the shuttle “significant.” But Katnik, a 20-year employee of Kennedy Space Center, said his

formal analysis had been summarized and “embellished” by a NASA writer for NASA Quest, an agency-run Web site aimed at schoolchildren. “It wasn’t meant to sound that dire,” he added. [“NASA worker says ’97 damage report not his, but is accurate,” **Orlando Sentinel**, February 4, 2003, p A10.]

◆ A recurring launch phenomenon that NASA engineers never considered a fatal threat to their space shuttles is now assumed to be the “root cause” of the loss of Columbia and seven astronauts. A chunk of foam fell from the external tank during liftoff, struck the heat-shielding tiles on Columbia’s belly and exploded into a cloud of tiny particles. Even NASA engineers’ worst-case analysis of the impact – a 2.6 pound piece of debris damaging a 7 by 30-inch swath of protective tiles, was deemed “no safety of flight issue” on the mission’s 12th day. Video, photographs and documents from the Ice & Debris Team at Kennedy Space Center shows the piece of foam hitting Columbia. That has spurred the intense speculation, though NASA executives urged caution. [“Tank foam assumed ‘root cause’ of failure,” **Florida Today**, February 4, 2003, p 1S & 4S.]

◆ President Bush on Monday vowed to continue space exploration in the wake of the shuttle Columbia tragedy, as Congress raised questions about whether cost overruns at other NASA programs hampered the shuttle’s safety. “While we grieve the loss of these astronauts, the cause for which they died will continue,” Bush said during an appearance at the National Institutes of Health in suburban Maryland on Monday. “America’s journey into space will go on.” Earlier, Bush received a 45-minute briefing in the Oval Office from NASA chief Sean O’Keefe. O’Keefe then met Monday night behind closed doors with 16 key congressional leaders. [“Bush vows to support space exploration,” **Florida Today**, February 4, 2003, p 6S.]

◆ The Bush administration’s vision of America’s future in space includes sending a nuclear-powered robot spacecraft to Jupiter and parking a communications satellite in Mars orbit by 2009. Those are just two programs highlighted in the budget request the National Aeronautics and Space Administration sent Monday to Congress. The annual spending blueprint, prepared long before Saturday’s loss of shuttle Columbia, seeks a 3.1 percent increase in total spending, which would bring the civilian space agency’s budget to \$15.4 billion. The Bush administration is expected to alter its spending priorities after the investigation into the shuttle loss. [“New budget features Jupiter trip,” **Florida Today**, February 4, 2003, p 6S.]

February 4: The President and Mrs. George W. Bush joined NASA Administrator Sean O’Keefe in paying tribute to the brave heroes of the Space Shuttle Columbia crew during a special memorial service at the NASA Johnson Space Center in Houston. The ceremony honored NASA astronauts Rick Husband, William McCool, Michael Anderson, Kalpana Chawla, David Brown, Laurel Clark, and Israeli astronaut Ilan Ramon. This was a private ceremony for family members, friends, and invited guests along with NASA employees and contractors. President Bush said the nation was “blessed” to have such men and women serving the space program, and although NASA is being tested at this time, “America’s space program will go on.” [“NASA provides update about Columbia investigation,” **NASA News Release #03-051**, February 4, 2003.]

◆ At the direction of the President, the flags of the United States are flying at half staff at the Kennedy Space Center today in honor of the seven astronauts who were lost in the Columbia accident on February 1. KSC Daily News. (2003). **Flags at Half Staff**. Available E-mail: KSCDailyNews@kscems.ksc.nasa.gov [2003, February 4].]

◆ Credible reports of space-shuttle parts found as far west as California and Arizona likely indicate that Columbia was breaking apart several minutes before it disintegrated over Texas, a NASA official said Tuesday. NASA investigators headed to the San Jose, Calif., and Phoenix areas to check out sightings of possible shuttle debris nearly 2,000 miles from the Texas and Louisiana debris fields where thousands of orbiter pieces have been found. NASA also disclosed Tuesday that an Apache military helicopter flying over Texas recorded images of the shuttle breaking up Saturday. That information has been sent to panels investigating the disaster, officials said. Two aerospace experts said that finding pieces of the orbiter in Arizona and California would bolster the agency’s leading theory: that damage to Columbia’s thermal protection tiles during the Jan. 16 liftoff caused it to break apart as it returned home. Such a breakup, they

said, could explain why Columbia's computers were reacting wildly as the shuttle crossed the West Coast, pitching it violently to stay on course as it sped toward its landing strip at Kennedy Space Center. In Florida, investigators studied sea currents in the Atlantic Ocean in an effort to determine where heat tiles or other parts that might have fallen off Columbia during its launch would have ended up. No tiles were found. The retrieval effort, led by the Environmental Protection Agency and Texas National Guard hazardous-materials specialists, crawled along. Only about 70 sites had been cleared by Tuesday night. Search efforts include seven Army and Air Force Black Hawk helicopters, five horse-back search teams and several groups on all-terrain vehicles. They are focusing on the more heavily wooded areas east of Nacogdoches and Lufkin, where the bulk of human remains and crew-cabin debris has been found. ["Debris points to breakup on West Coast," **Orlando Sentinel**, February 5, 2003, p A3.]

◆ A total of 288 prime contractors in Florida – 111 of them in Brevard County – can expect to take direct hits from the grounding of NASA's shuttle fleet. It remains unclear how long NASA would keep its shuttle fleet grounded, but the effects will ripple far beyond the Space Coast, where 15,000 work at Kennedy Space Center alone. A vendor list from Florida Space Authority shows the contractors who do business with NASA, the U.S. Air Force and other government agencies, all of which could feel a financial pinch. ["Shuttle grounding could slam contractors," **Florida Today**, February 5, 2003, p 1S & 7S.]

◆ While it is too early to put a price tag on the shuttle's financial loss, it is clear NASA will bear the brunt. And as a government agency, it cannot recover those costs because its property is not insured. Neither can most of the universities and other entities with projects aboard, valued at between \$30 million and \$40 million by one estimate. Overall, the loss will run into the billions. Columbia itself cost about \$1 billion to build in the 1970s, and hundreds of millions more to maintain and upgrade, experts said. NASA declined to comment on the expense. One insured piece on Columbia was Spacehab's Research Double Module, which carried more than 50 experiments. The module cost \$100 million to develop, said Kimberly Campbell, spokeswoman for Spacehab, a provider of commercial space services. She declined to give the amount of coverage. ["Columbia not insured, cost falls to NASA," **Florida Today**, February 5, 2003, p 7S.]

◆ Cape Canaveral Air Force Station's unmanned rocket launches will not be affected by the Columbia accident, military and company officials said Tuesday. The unmanned-rocket program is worth up to several billion dollars a year, with a local work force of close to 2,000 people. The only change to the rocket launch schedule at the Air Force Station because of the Columbia accident is the rescheduling of Friday's launch of a Boeing Delta 4 rocket to Monday, said U.S. Air Force Lt. Col. Mike Rein. The rest of this year's launch schedule is still the same, barring any routine schedule changes that come up, such as bad weather, Rein said. ["Unmanned rocket programs continue," **Florida Today**, February 5, 2003, p 7S.]

February 5: Deputy NASA Administrator Frederick Gregory will render honors to the crew of the Space Shuttle Columbia at Dover Air Force Base in Delaware. The remains of the orbiter's seven astronauts were transported to Dover in flag-draped caskets. The seven astronauts - Commander Rick Husband (Colonel, USAF), Pilot Willie McCool (Commander, USN) and Mission Specialists Michael Anderson (Lieutenant Colonel, USAF), David Brown (Captain, USN), Kalpana Chawla and Laurel Clark (Commander, USN), and Payload Specialist Ilan Ramon (Colonel, Israel Force) - died Saturday when the Space Shuttle Columbia broke up over the southern United States. The Charles C. Carson Center for Mortuary Affairs at the base will prepare the remains for return to the families. Ramon's remains will be flown to his home in Israel for burial. Final funeral arrangements for the crew are still to be announced. ["Deputy Administrator Meets Space Shuttle Columbia Astronauts' Remains at Dover AFB," **NASA News Release #03-053**, February 5, 2003.]

◆ Workers will reassemble the pieces of shuttle Columbia at Kennedy Space Center, said NASA's shuttle program manager Ron Dittmore. "Eventually our plan is to move the debris to the Kennedy Space Center," he said. Currently the debris from Columbia is being collected at Barksdale Air Force Base near Shreveport, La. The first truckload of debris arrived there Wednesday. Officials have yet to determine when it will be moved to KSC, where workers will lay out the pieces and reconstruct the orbiter. Dittmore did not elaborate, but an obvious benefit of bringing the wreckage to Kennedy Space Center is that there is a concentration of shuttle engineering mechanical expertise there. The shuttle is prepared for launch at

KSC and there are thousands of employees who know the intricacies of the ship. Shuttle Challenger was reconstructed at the Logistics Facility on Contractor Road after the Jan. 28, 1986, accident. After the investigation, its remains were buried in a silo at Cape Canaveral Air Force Station. KSC has several other spaces large enough to do this project, including the hangar built by Florida Space Authority designed to house the X-33 vehicle, once thought to be a potential shuttle replacement before NASA canceled the project. ["Brevard to be reassembly site," **Florida Today**, February 6, 2003, p 1A.]

◆ NASA is exploring the possibility that the shuttle Columbia was struck by a piece of debris or rock in orbit, fatally wounding the spaceship, officials said Wednesday. In Washington, Michael Kostelnik, deputy associate administrator for the shuttle and a retired Air Force major general, said the shuttle suffered some sort of "anomaly" over California. What's more, he said, the plasma draped over the spacecraft as it raced over California changed colors at one point, suggesting that the craft may have struck an object, he said. NASA engineers say they are weighing the possibility that the space shuttle's heat-resistant tiles may have been damaged by space junk or a tiny space pebble, known as a micrometeorite. The space agency has not yet found any evidence that a collision occurred, but it is considering that scenario among many others as investigators struggle to explain the disaster. ["NASA studies possibility of space junk role," **Florida Today**, February 6, 2003, p 2S.]

◆ Despite gathering more than 12,000 pieces of debris from the shuttle Columbia, a NASA official said Wednesday none of the pieces provides critical answers for why the shuttle broke up. "We do not have any red-tag items," said Ron Dittmore, shuttle program manager, referring to items engineers have identified as crucial to the investigation into the cause. He said those items would include parts of the left wing, data recorders and certain pieces of insulation and tiles. ["NASA: Search for crucial pieces coming up short," **Florida Today**, February 6, 2003, p 4S.]

◆ In an effort to crack down on souvenir hunters, federal authorities Wednesday indicted two Texas residents on theft charges and announced a brief amnesty period during which people who stole shuttle debris could return the wreckage without fear of prosecution. The indictments and amnesty program are aimed at encouraging people, or scaring them, into returning debris. The FBI has about 20 ongoing investigations into shuttle debris theft. ["Feds indict two in theft cases," **Florida Today**, February 6, 2003, p 4S.]

◆ Union officials at Kennedy Space Center said Wednesday they are concerned the shuttle Columbia disaster will result in layoffs, or at least the loss of overtime work for space center workers. Workers are on edge about the situation, reminding some of the widespread job losses at the space center following the 1986 shuttle Challenger explosion. The space program employs between 14,000 and 15,000 workers locally, including many who work in the shuttle program, according to NASA. Union officials said NASA hasn't said anything definitive about the potential for layoffs resulting from the Columbia disaster. ["Unions fear KSC layoffs," **Florida Today**, February 6, 2003, p 6S.]

◆ Security arrangements for families and dignitaries attending the space shuttle Columbia lift-off in January will cost taxpayers \$225,000, officials learned on Wednesday. The bulk of the expenses include salaries for at least 250 law enforcement agents and other logistical considerations in securing the crew members' families and nearly 300 Israeli citizens and dignitaries during their four-day stay in Brevard County. The sheriff's department deployed the law enforcement agents – including five SWAT teams and 10 motorcycle officers – in and around Kennedy Space Center in part because of worries over potential terrorist attacks. NASA and Israeli embassy officials also requested the sheriff's office get involved because the families and dignitaries were going to stay in and around the Cocoa Beach area. The security arrangements leading up to the Jan. 16 launch of Columbia were extraordinary. ["Jan. 16 launch security to cost \$225,000," **Florida Today**, February 6, 2003, p 6S.]

◆ NASA was repeatedly warned for years by safety panels and government auditors that extensive job cuts put the shuttle program at risk, and the agency was told just three days before the Columbia disaster that its work force was understaffed and under stress. Critics have long worried that the space agency has risked lives by cutting too deeply, although there is no indication that work-force problems contributed directly to the loss of the shuttle and its seven-member crew Saturday. Since 1993, the National

Aeronautics and Space Administration has sliced nearly 7,000 jobs, including oversight and other shuttle-related positions at Kennedy Space Center. As far back as 1996, an independent panel of experts predicted that continuing budget cuts could threaten shuttle safety. The report by the Aerospace Safety Advisory Panel singled out KSC as the NASA center that would have the toughest time maintaining shuttle safety while cutting workers. "KSC faces a management challenge of major dimensions if it is to maintain a work force of sufficient size, skills and experience to achieve acceptable levels of safety," the report stated. In 2000, the space agency was slammed with three major reports critical of its workforce troubles. "The large reduction in NASA quality assurance inspectors for each shuttle is very disturbing," concluded one independent panel chaired by one of NASA's own: Henry McDonald, former director of the Ames Research Center. NASA maintains that staffing cuts never jeopardized shuttle safety and that the reductions were made to eliminate redundant duties. ["Agency cuts risked lives, critics say," **Orlando Sentinel**, February 6, 2003, p A1 & A5.]

◆ Congress will open its hearings into the Columbia disaster on Wednesday, as lawmakers scramble to figure out whether NASA needs an immediate infusion of money. Sen. John McCain, R-Ariz., said his Senate Commerce Committee will open its investigation into the loss of the space shuttle Wednesday in a joint hearing with the House science subcommittee on space. NASA Administrator Sean O'Keefe will testify. Also next week, budget writers are expected to finish the spending plan for this year. Sens. Bill Nelson, D-Fla., Kit Bond, R-Mo., and others are asking for extra money for the National Aeronautics and Space Administration. Sen. Ted Stevens, R-Alaska, chairman of the Senate Appropriations Committee, said he would give NASA more money if the Bush administration asks for it. ["Congress will join investigations of Columbia disaster," **Orlando Sentinel**, February 6, 2003, p A3.]

February 6: The next launch scheduled is the Galaxy Evolution Explorer (GALEX) aboard a Pegasus XL rocket from Cape Canaveral Air Force Station March 25. The Pegasus is planned for ferry to CCAFS on an L-1011 aircraft Feb. 18. GALEX is a NASA UV imaging and spectroscopic survey mission designed to map the global history and probe the causes of star formation and its evolution over the ultraviolet range. Following GALEX will be the launch of the Propulsive Small Expendable Deployer System (ProSEDS) aboard a Delta II rocket March 29 from CCAFS. ProSEDS is a tether-based propulsion experiment that draws power from the space environment around Earth, allowing the transfer of energy from Earth to the spacecraft. ["Two NASA ELV launches from CCAFS in March," **KSC Countdown**, February 6, 2003.]

◆ Officials are making plans to add seven more names from the space shuttle Columbia to the memorial built to honor America's fallen astronauts. The Space Mirror Memorial, located at Kennedy Space Center's Visitor Complex, has never included the name of a non-U.S. citizen. The Astronaut Memorial Foundation board members consulted with each other after the fate of the Columbia crew was known Saturday to clarify that Israeli astronaut Ilan Ramon could be included. "He was flying with an American crew on an American vessel," said Stephen Feldman, president of The Astronaut Memorial Foundation. "If he was flying with an American crew, then he is included." The names from the Columbia disaster could be added to the monument as early as this summer, Feldman said. A committee made up of former astronauts, space program officials and crew members' relatives will decide when to add the names and where to add the names. Web posted. (2003). [Space shuttle: Names of Columbia's astronauts will be added to monument [Online]. Available WWW: <http://www.naplesnews.com/> [2003, February 6].]

◆ Launch photos that could have shed light on what brought about the loss of the space shuttle Columbia and its crew will not help the investigation because they are too blurry, according to NASA. "It's a disappointment that the camera with the very best [launch] view turned out to be out of focus," shuttle flight manager Ron Dittmore said Thursday. "We've tried to look at alternate camera views, but we know we're not going to get the best view that we could have." The shuttle, with seven astronauts onboard, broke up over Texas during re-entry attempt on Saturday, shortly after experiencing high heat and air resistance on its left side and wing. The possibility that a piece of external fuel tank foam struck and damaged heat-insulation tiles on the shuttle's left wing during launch as an early suspect. Web posted. (2003). [NASA: Key launch pics not in focus [Online]. Available WWW: <http://www.cnn.com/> [2003, February 6].]

◆ High-resolution images taken from a ground-based Air Force tracking camera in southwestern U.S. show serious structural damage to the inboard leading edge of Columbia's left wing, as the crippled orbiter flew overhead about 60 sec. before the vehicle broke up over Texas killing the seven astronauts on board Feb. 1. According to sources close to the investigation, the images, under analysis at the Johnson Space Center in Houston, show a jagged edge on the left inboard wing structure near where the wing begins to intersect the fuselage. They also show the orbiter's right aft yaw thrusters firing, trying to correct the vehicle's attitude that was being adversely affected by the left wing damage. Columbia's fuselage and right wing appear normal. Unlike the damaged and jagged left wing section, the right wing appears smooth along its entire length. The imagery is consistent with telemetry. The ragged edge on the left leading edge, indicates that either a small structural breach – such as a crack – occurred, allowing the 2,500F reentry heating to erode additional structure there, or that a small portion of the leading edge fell off at that location. Either way, the damage affected the vehicle's flying qualities as well as allowed hot gases to flow into critical wing structure – a fatal combination. It is possible, but not yet confirmed, that the impact of foam debris from the shuttle's external tank during launch could have played a role in damage to the wing leading edge, where the deformity appears in USAF imagery. Web posted. (2003). [USAF Imagery Confirms Columbia Wing Damaged [Online]. Available WWW: <http://www.spaceref.com/> [2003, February 6].]

◆ With Columbia's destruction, NASA must now operate with just three space shuttles, and officials said Thursday they may be forced – as a last resort – to consider mothballing a spacecraft for spare parts just to cobble together an abbreviated launch schedule. Many of the shuttle program's original manufacturers are long gone, and, even with warehouses full of parts at the Kennedy Space Center, there are often a finite number of supplies available to maintain the fleet. Though it's happened less frequently in recent years, engineers, faced with a dwindling pool of dated hardware, have been forced with some regularity to take parts from one shuttle and use them in another to keep its launch schedule on target. That process is known as "cannibalization." Now there are just three space shuttle remaining – Discovery, Atlantis and Endeavour – and NASA has no plans to build a new craft. ["Spare parts problem looms," **Florida Today**, February 7, 2003, p 2S.]

◆ As the independent panel members arrived in Houston, NASA Administrator Sean O'Keefe told reporters the government planned to revise the charter of the board to allow for additional members. The new members, O'Keefe said, will likely be people without any "specific association or involvement with NASA," and will add new expertise and new "voice." "This is to absolutely guarantee that we eliminated any ambiguity as to the independence of this board," O'Keefe said. "We want to be sure that we are not eliminating any sort of possibilities of what could have contributed to this accident." O'Keefe's announcement came after 16 House Democrats sent a letter to President Bush urging him to expand the panel and its charter, which calls for it to answer to NASA, not to the President or congress. The Democrats' letter said the panel had the "appearance of non-independent board controlled by NASA." ["NASA to add more 'voices' to panel," **Florida Today**, February 7, 2003, p 3S.]

◆ At a solemn Washington memorial service Thursday for the seven astronauts of shuttle Columbia, Vice President Cheney hailed the crew as courageous explorers bound not by faith or heritage, but by "the great cause of discovery." Many tributes will be made in the astronauts' honor, Cheney told 1,700 mourners who gathered beneath the arched limestone pillars of Washington National Cathedral, but "their greatest memorial will be a vibrant space program and new missions." The vice president was one of several speakers who vowed that the nation and its space agency would carry on, despite Saturday's shuttle disaster. During the 90-minute ceremony, Cheney, NASA Administrator Sean O'Keefe and Robert Cabana, NASA's director of shuttle flight crew operations, spoke of the great personal risks that all astronauts have made to extend the reach of humans far beyond the Earth. The nave of the Northwest Washington church was filled with members of Congress, NASA employees, family and friends of the astronauts, military personnel and a sprinkling of people without title or close ties to the crew. ["D.C. honors fallen crew," **Florida Today**, February 7, 2003, p 6S.]

February 7: Those closest to the shuttle's launches and landings shared a profound sorrow Friday over Columbia's seven fallen astronauts while celebrating their lives. Ominous, dark clouds rolled in as more than 8,000 people sat or stood at the southern end of the 3-mile-long runway at Kennedy Space Center,

where Columbia would have landed last Saturday. "This is the place where our space exploration dreams take flight," NASA administrator Sean O'Keefe said. "From here, seven courageous astronauts sailed to the heavens on their daring adventure of exploration and discovery. This is where the great lives are defined by great purposes." The service centered on themes of family, the astronauts' inspirational lives and continued commitment to the space program. "With God's help, we can endure this hardship and begin once again to focus on the future," said James Jennings, former deputy director of KSC and a NASA official. Bob Crippen, Columbia's first pilot, praised the ship's accomplishments as a research vessel and recalled its history as the oldest shuttle. A few drops of rain sent a wave of restlessness through the crowd, but the sun brightened the stage briefly as Gov. Jeb Bush spoke. "We Floridians are so proud of this place," Bush said of KSC. Col. Jim Halsell, an astronaut who was the launch integration manager at KSC, spoke of the bond felt by those who work with the astronauts. Some workers laid flowers on the landing strip. For many, the most powerful moment of the ceremony came at the end, after a mournful rendition of "Taps," when astronauts flew four T-38 airplanes over the crowd. The airplane flown by Alan Poindexter and Joan Higginbotham peeled away, the "missing man" in the formation, as spectators wiped away tears. The jet engines seemed to echo forever, the sound reflecting off the clouds. ["Hail Columbia," **Florida Today**, February 8, 2003, p 1S & 3S.]

◆ Former astronaut Robert Crippen, pilot of the shuttle Columbia for its maiden voyage in 1981, remembered NASA's oldest orbiter today in a moving tribute before a throng of workers gathered on the broad shuttle runway at the Kennedy Space Center. It was at that same runway that technicians, engineers, family members and journalists gathered last Saturday to welcome Columbia and its seven-member crew back to Earth after a successful 16-day science mission. But they waited in vain. Columbia was destroyed just 16 minutes before its anticipated arrival when it veered out of control in the thin air 200,000 feet above Texas. Crippen, who helped oversee NASA's initial response to the 1986 Challenger disaster, first flew in space aboard Columbia on April 12, 1981, when he and Commander John Young rocketed away from pad 39A. More than two decades later, he delivered Columbia's eulogy, struggling to keep his emotions in check as he remembered the shuttle and its fallen crew. "We're gathered here this morning to honor and salute the Columbia crew and mission STS-107," he said. "The grief in the hearts of the crew's families and the entire NASA family, which includes all of our contractor community which supports the agency, is very heavy. Still, this crew lived lives that deserve our celebration. Yes, they were cut short. But these brave men and women lived their lives to the fullest doing much more in their time here on Earth than many can imagine. Words at a time like this seem weak. They don't fully communicate the depth of our feelings. The NASA family speaks much clearer with actions. The action that is being taken to find the cause of the accident, correct it and continue the crew's journey of discovery in space is the grandest tribute that we can pay to them. I'm certain that is what they would have wanted. It is fitting we are gathered here on the shuttle runway for this event," Crippen said. "It was here last Saturday that family and friends waited anxiously to celebrate with the crew their successful mission and safe return to Earth. It never happened. I'm sure that Columbia, which had traveled millions of miles and made that fiery re-entry 27 times before, struggled mightily in those last moments to bring her crew home safely once again. She wasn't successful. Columbia was a fine ship. She was named after Robert Gray's exploration ship, which sailed out of Boston Harbor in the 18th century. Columbia and the other orbiters were all named after great explorer ships, because that is their mission, to explore the unknown. Columbia was hardly a thing of beauty, except to those of us who loved and cared for her," Crippen said. "She was often bad mouthed for being a little heavy in the rear end. But many of us can relate to that. Many said she was old and past her prime. Still, she had only lived barely a quarter of her design life; in years, she was only 22. Columbia had a great many missions ahead of her. She, along with the crew, had her life snuffed out in her prime. I was here at the shuttle runway in March of 1979 when Columbia first arrived at the Kennedy Space Center. She came in on the back of a 747 escorted by Deke Slayton in a T-38. She certainly wasn't very pretty at that time. A large number of her tiles had not been installed and many that had were not adhering very well. KSC management made a fairly unpopular statement at the time, that it was going to take several years to get her ready to fly. They were right. Readied for launch by the loving care of the Kennedy team, the same care they've given to all 28 of her flights, she was finally ready to fly in April 1981. John Young and I were privileged to take her on that maiden flight. She performed magnificently, the world's greatest electric flying machine was what John described her as. Because she was a little heavy, she didn't get some of the more glamorous missions. But she was our leader in doing science on orbit. Just as she was doing with this crew in Spacehab on mission STS-107, microgravity scientific exploration was her bag. She carried

Spacelab numerous times, studying materials processing, life sciences, all of which were focused on giving us a better life here on Earth. Columbia also helped us better understand about the heavens and understand the origins of the universe with several missions, including Astro, also deploying the most advanced X-ray observatory ever built, the Chandra X-ray Telescope, and by her very recent Hubble Space Telescope servicing mission. Just as the crew has, Columbia has left us quite a legacy. There's heavy grief in our hearts, which will diminish in time, but it will never go away and we will never forget," Crippen said. "Hail Rick, Willie, KC, Mike, Laurel, Dave and Ilan. Hail Columbia." Web posted. (2003). ['Hail Columbia' [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, February 7].]

◆ NASA's Kennedy Space Center (KSC), Fla., has awarded the University-affiliated Spaceport Technology Development Contract (USTDC) to the ASRC Aerospace Corporation of Greenbelt, Md. The contract is a cost-plus award fee/incentive fee performance-based indefinite delivery/indefinite quantity (ID/IQ) contract. The contract features a four-year, seven-month basic period of performance beginning March 1, 2003, with five one-year options for a potential nine-year seven-month contract term. The basic contract's estimated cost is \$220 million with a potential value of \$600 million over the entire period inclusive of the five one-year options. Under the contract, ASRC Aerospace, along with their USTDC partners; Swales Aerospace, Beltsville, Md.; Sierra Lobo, Inc., Milan, Ohio; and the University of Florida, Gainesville, Fla., will provide non-routine engineering development products and services to operational customers performing processing, launch, landing, and range activities at KSC. ASRC will perform applied research and development functions to meet future technology challenges. The work will be performed at KSC and at NASA facilities located on Cape Canaveral Air Force Station, Fla. ASRC Aerospace is a wholly owned subsidiary of the Arctic Slope Research Corporation, Barrow, Alaska. ["NASA Awards Spaceport Technology Development Contract," **NASA News Release #c03-003**, February 7, 2003.]

February 8: When the government made the historic decision in 1996 to turn over the day-to-day operations of its space shuttle fleet to a private company, perhaps the most critical task it faced was crafting a contract that would balance efficiency with safety. NASA officials decided the best way to meet that challenge was to link the goals to something a business would be sure to understand: money. There were bonuses for a safe return of the ship and rewards for coming in under budget. There also were penalties for problems -- aborting a mission on the launch pad would cost the company \$3 million, a cancellation after the craft was already in the air, \$5 million. A "catastrophic loss," defined as an incident that resulted in the loss of crew or the orbiter, would cost the company six months' worth of fees if the contractor were found at fault. For the period the Columbia flew, those fees total about \$42 million. The partnership between NASA and United Space Alliance, a joint venture between Lockheed Martin Corp. and Boeing Co. based here, was meant to revitalize the space program amid budget cuts and criticism that the agency was becoming a bloated bureaucracy. "Faster, cheaper, better" was the motto of the day. And through its contract with United Space, NASA boasts that it has cut the size of the shuttle workforce by one-fourth and reduced the average cost per flight from \$600 million to \$400 million. The original six-year contract was renewed in October 2002 for another two years. Web posted. (2003). [Bonuses for A Safe Return, Fees for Loss of Mission [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, February 8].]

◆ Investigators are studying military radar data that could show a small object coming off shuttle Columbia the morning after its Jan. 16 launch. The data could mean Columbia was hit by space debris in orbit. Or the object could be frozen wastewater that is routinely dumped from the shuttle. Analysts are considering all possibilities. "I can confirm NASA is aware of the data and is looking at it," agency spokesman Kyle Herring said, "but it's very preliminary." NASA reportedly received the information only recently from the Air Force. The Colorado-based Air Force Space Command monitors more than 9,000 pieces of orbital space junk. The shuttle routinely alters its flight path to avoid possible collisions but has been nicked by small pieces of debris in the past. Engineers are checking flight data from Columbia's mission for any signs of a possible impact. ["Radar tracked object close to shuttle," **Orlando Sentinel**, February 9, 2003, p A29 & A34.]

◆ Search crews have recovered what may be the door to a wheel well of space shuttle Columbia, authorities said Saturday. The 300-pound piece, 6 feet by 8 feet long, is one of the largest objects recovered in recent days in the east Texas search area where much of the shuttle debris fell. Nacogdoches County Sheriff Thomas Keress said the piece was taken to the Nacogdoches County Expo Center, a rodeo

venue now being used as a collection site for wreckage that eventually will be transported to Kennedy Space Center. Kerss said searchers also found some computer parts. NASA workers have joined the recovery effort to judge the significance of the pieces being found, he said. ["Columbia part might be door to wheel well," **Orlando Sentinel**, February 9, 2003, p A33.]

◆ The first pieces of space shuttle Columbia should return to Kennedy Space Center by the middle of this week, completing a journey that began Jan. 16 when the orbiter launched from Florida, NASA said Saturday. "The first pieces are almost ready to ship, and Kennedy is preparing a facility for them," NASA spokesman Dave Drachlis said. While engineers in Florida will examine the wreckage for clues, experts at Johnson Space Center in Houston are studying computer data and amateur and military photographs and video of Columbia's path. ["Shuttle pieces should return to KSC by middle of week," **Orlando Sentinel**, February 9, 2003, p A34.]

◆ A three-day amnesty period to turn over looted shuttle debris brought in hundreds of pieces of the shattered Columbia, but officials said Saturday that people are still illegally hoarding the debris and at least nine could soon face charges. "We're down to nine investigative complaints turned over to a U.S. attorney in Lufkin," Nacogdoches County Sheriff Thomas Kerss said Saturday. Sheriffs in other counties said they had received tips about possible looting as well. ["People still hoarding debris, police say; charges to come," **Orlando Sentinel**, February 9, 2003, p A34.]

◆ Spending caps and management weaknesses combined to stretch NASA's space shuttle program to the limit during the 1990s. Lawmakers, experts from the General Accounting Office, NASA's own safety advisory panel and even an independent commission sounded multiple warnings that the aging shuttle fleet needed help. While NASA officials studied and acknowledged these warnings, the agency stressed safety was always its top concern and a flat budget and diminished work force were not compromising the lives of the crews. "I can tell you as a matter of fact that the issue of safety in NASA has always been No. 1," said Michael Kostelnik, deputy associate administrator for the space station and shuttle programs. Safety, he said "is the top goal in the shuttle program: Fly safe, meet the mission, improve the orbiter." Former NASA Administrator Dan Goldin optimistically reported to Congress that the shuttle was costing less, gaining in safety and becoming more efficient in the hands of contractors whose numbers were far smaller than the teams of civil servants who had once worked on the 90-ton orbiters. In 1996, the shuttle program stopped changes to the orbiters' design so scarce resources could be focused on developing a next-generation vehicle, former astronaut Bryan O'Connor told a congressional panel in September 2001. He is now a NASA associate administrator and a participant in the Space Shuttle Mishap Interagency Investigation Board. The design freeze was lifted in 1997, but the \$100 million a year NASA earmarked for shuttle improvements was enough for only minor enhancements. Constant cost overruns and schedule delays in the \$30 billion International Space Station program bled the agency's attention and resources. Last year, it became clear NASA had no workable shuttle replacement on the drawing board and that the aging orbiter fleet would have to remain in service until at least 2015. NASA managers were confident the shuttle was safe. Since then, NASA has approved the Space Shuttle Service Life Extension Program, an effort to refine more than 300 possible shuttle improvements and produce a blue-print for modernizing the remaining shuttles so they can operate safely through at least 2015. ["NASA stretches safety budget," **Florida Today**, February 9, 2003, p 1A & 2A.]

◆ The shuttle Columbia disaster hasn't changed attendance much at Kennedy Space Center Visitor Complex, except for the thousands who have visited the park's astronaut memorial. Attendance slumped earlier last week, but currently is running about the same as it was during the same time last year, said Dan LeBlanc, chief operating officer for Delaware North Parks Services of Spaceport, the company that manages the complex for NASA. Thousands of people have visited the Space Mirror last week in the wake of the Columbia disaster, including many who have left flowers and written messages in a book left at the memorial so visitors can pass on their thoughts about the tragedy, LeBlanc said. On Feb. 1, the day the Columbia and its seven-member crew perished, Delaware North allowed people into the park at no charge, but has since resumed its regular admission fees. ["Turnout steady at Visitor Complex," **Florida Today**, February 9, 2003, p 4A.]

◆ The contractor that handles day-to-day operation of the space shuttle fleet is protected from lawsuits under an agreement that could leave NASA footing any of the contractor's liability from the Columbia accident. NASA indemnified the United Space Alliance from third-part claims to avoid the high cost of insurance, alliance spokesman Mike Curie said Friday. The alliance – which consists of Lockheed Martin and Boeing – doesn't carry any additional liability insurance to cover those risks, he said. "The Columbia tragedy would be covered by this indemnification," Curie said. That means NASA – funded largely by taxpayers – would probably cover any damages awarded to the Columbia astronauts' families. However, if the alliance was found to have committed gross negligence or to have otherwise failed to do what NASA instructed, it could be liable, said William Maready, a North Carolina attorney who sued on behalf of an astronaut's family in the 1986 Challenger disaster. Most of the Columbia astronauts were federal employees, so their families cannot sue the federal government. It is unlikely that the government could successfully extend that immunity from lawsuits to the contractors it indemnified, Maready said. ["Lead shuttle contractor has shield from lawsuits," Orlando Sentinel, February 9, 2003, p H2.]

February 9: Space shuttle Columbia investigators Sunday continued to debate whether the ill-fated shuttle might have been struck by a piece of space debris or a micro-meteorite. More than a week after Columbia disintegrated upon its return to Earth, investigators were still searching for answers, and thousands of workers were still scouring the ground in search of the shuttle's remnants. Some of the most recent debate about what happened to Columbia has focused on radar data. Air Force radar picked up something in the shuttle's vicinity just 24 hours and 20 minutes after its Jan. 16 launch. It was traveling about 11 mph and reportedly was tracked for two days before it was thought to have re-entered Earth's atmosphere. "We're looking at it. Right now it is just a piece of very raw data," said NASA spokesman Allard Beutel. There had been earlier speculation that the object could have been wastewater, which is periodically ejected from the shuttle. However, NASA spokesman Rob Navias said Sunday that Columbia had no scheduled water dumps by that point in the flight. Engineers are checking data from the shuttle's flight-control systems for signs of anything that may have impacted the shuttle and might have gone previously unnoticed. Still under consideration is whether foam from the insulation on the external fuel tank broke off and damaged the shuttle's delicate heat-protection tiles. ["Space-debris possibility spurs debate," Orlando Sentinel, February 10, 2003, p A1 & A10.]

◆ Despite questions about the independence of a panel assigned to investigate the space-shuttle disaster, members of the investigation board said during the weekend that they will not be influenced by NASA. Some even question whether the agency has too hastily narrowed its investigation. Some members of the Columbia Accident Investigation Board also distanced themselves from earlier suggestions by NASA officials that particular theories – such as foam insulation hitting a wing – had been ruled out. "NASA may rule out something," the head of the board, retired Navy Adm. Harold Gehman, said. "But they may have to prove it to us. We're approaching it from a different point of view. Not only do we have to pursue the likely causes, but we have to pursue the unlikely causes." Gehman said the board will rely heavily on a team of non-NASA experts – academics, engineers, metallurgists, even lawyers – to double-check any questionable findings from the space agency's own investigators and engineers. The panel was to reconvene in Houston on Sunday night for what is likely to be months of intensive investigation. ["NASA won't influence us, Columbia panel members say," Orlando Sentinel, February 10, 2003, p A9.]

February 10: Five days before Columbia's disastrous landing attempt, shuttle flight controllers called an engineer at NASA's Langley Research Center asking what might happen if the orbiter tried to land with flat tires or excessive heat in one of its landing gear wheel wells. The inquiry on Jan. 27 from Johnson Space Center came after mission managers decided a chunk of foam falling from the external tank had not damaged heat-shielding tiles enough to pose a flight safety issue. The talks, which were confirmed Monday by officials at three NASA centers, centered around whether damage to the thermal protection system could cause excessive heat inside the wheel well, damaging the landing gear or deflating tires. Langley replied that excessive heat in the wheel well could deflate the tires or prevent the gear from deploying at all. The question came from a group of flight controllers who watch over landing gear and tires. Johnson Space Center spokesman James Hartsfield said they were wondering whether the analysis being used in Houston was incorrect. He said that did not mean the flight controllers disagreed with any final decision about whether the foam could have damaged the orbiter and noted they did not take any action based on what they heard back from Langley. "We train all flight controllers to be devil's

advocates," Hartsfield said. "We train them to look at every possibility." The final decision about whether the foam could have seriously damaged the orbiter was noted in a mission management report dated Jan. 28, but Hartsfield said the controllers called Langley after the decision was made. If Hartsfield is correct, that would indicate at least some flight controllers were still wondering about the potential consequences. In two reports during the 1990s, university researchers warned NASA that tiles in the area of the landing gear wells were among those most susceptible to failing and, if they did fail, posed the greatest risk of losing an orbiter. The Johnson controllers called on Langley because the Hampton, Va., center does testing on the shuttle landing gear, tires and thermal protection system. The latter tests include use of a special high-temperature wind tunnel. ["NASA weighed re-entry risks," **Florida Today**, February 11, 2003, p 1A & 4A.]

◆ Workers at Kennedy Space Center have marked a large grid in a hangar near the shuttle landing strip to prepare for the arrival of Columbia debris Wednesday. Monday afternoon, in the echoing, nearly empty hangar created for the yet-to-be-built successor to the space shuttle, lines of wide blue tape cut across a yellow grid taped to the gray cement floor. The blue lines made eerie outlines of shuttle parts, in particular, the wings. Readings from Columbia's disastrous entry into the atmosphere Feb. 1 showed a series of failures on the left wing. Investigators will reconstruct three layers of that wing, including the thermal protection system -- the tiles were potentially damaged when the shuttle lifted off Jan. 16. Each wing has three reconstruction areas marked on the hangar floor. There's also an area for fuselage parts in the 50,000-square-foot hangar, which chief shuttle contractor United Space Alliance rents from the Florida Space Authority. The panel of outside investigators looking into the disaster will get its first look at the facility Wednesday, when the first loads of debris are expected by truck, a KSC spokesman said. The pieces will be laid out at KSC, but the inquiry board has done little review of the shuttle parts that are being retrieved in east Texas. Instead, board members are getting a crash course about the shuttle in hopes of explaining why data from the orbiter's left wing and landing gear showed abnormally high temperature readings and sensor failures before Columbia disintegrated 40 miles above Texas, just 16 minutes before a planned landing in Florida. Left-wing temperature readings were lost three minutes before mission control lost communication with the seven astronauts at 9 a.m. Feb. 1. After checking out Kennedy Space Center, the accident investigation board will visit Marshall Space Flight Center in Huntsville, Ala., where space shuttle engine and propulsion technologies are developed. It's NASA's lead center for developing space transportation systems. ["Shuttle debris head to KSC," **Florida Today**, February 11, 2003, p 4A.]

◆ NASA officials confirmed Monday that a piece of wing recovered last week from Columbia came from the shuttle's left side, adding potentially critical insight to the investigation. Administrator Sean O'Keefe said the first truckloads of debris are heading to Kennedy Space Center, where investigators will attempt to re-assemble the ship and search for clues. The pieces should start arriving Wednesday. O'Keefe stressed that NASA has "no favorite theory" for the cause of the Feb. 1 accident that killed seven astronauts. He said everything remains on the table as an independent board takes over the investigation. NASA's chief also defended that group -- the Columbia Accident Investigation Board -- which has been criticized as being too close to the space agency. O'Keefe said the board, now setting up shop in Houston, will do its job without influence from the space agency. "I think it's going to give us a fighting chance of coming up with a judgment that is unbiased and uncluttered," he said. Meanwhile, the wing segment may prove crucial to the investigation because rising temperatures and loss of sensors indicate that Columbia's troubles started in the left wing. It is the same region where a chunk of foam insulation from the external tank came crashing down during Columbia's launch Jan. 16, leading to speculation that the foam may have damaged some of the shuttle's heat-protective tiles. ["Officials confirm recovered wing piece is from left side," **Orlando Sentinel**, February 11, 2003, p A8.]

◆ The Air Force has closed the Eastern Range along Florida's Space Coast for the next four weeks to replace key computer systems as the next step in a \$1 billion modernization program. As a result, no rockets will lift off from Cape Canaveral Air Force Station or Kennedy Space Center until the work is done, said Bob Fore, executive director of the Eastern Range for the 45th Space Wing at Patrick Air Force Base. "We're replacing the heart of the command and control system that we use to monitor the flight of the launch vehicles and to perform the public safety mission," Fore said. The Eastern Range is managed by the Air Force and describes the area a rocket launching from the Cape flies over on its way into orbit. Tracking stations along Florida's Atlantic coast and on islands downrange follow the progress of the launch

and stand ready to destroy the booster should it fly off course. At the same time, the range takes data radioed from the rocket and helps transfer it back to mission managers for analysis during and after the flight. Planned long before the Feb. 1 loss of shuttle Columbia, the range closure means that several missions nearly ready to fly won't be able to get off the ground until at least March 4. Web posted. (2003). [Eastern Range Shut Down for Upgrades Through March 4 [Online]. Available WWW: <http://www.space.com/> [2003, February 11].]

February 11: The independent board conducting an inquiry into the Columbia disaster will examine the "larger organization" to see if NASA is "managing a safe program," the panel's chairman said Tuesday. The shuttle accident board's 11 members met with the news media for a formal news session for the first time Tuesday at Johnson Space Center in Houston. The panel members are set to tour Kennedy Space Center today and Thursday. Some shuttle debris recovered from the disaster is expected to arrive at KSC today from Barksdale Air Force Base near Shreveport, La. Board chairman Ret. U.S. Navy Adm. Hal Gehman Jr. promised an unbiased probe, even if it means searching for answers in the offices of the managers of NASA. The board also answers to NASA, but Gehman said supervisors and managers are "fair game." ["Board to probe overall safety," **Florida Today**, February 12, 2003, p 4A.]

◆ International Space Station Commander Ken Bowersox said Tuesday the "most likely extension" of his crew's mission would be two to four months, a timeframe that coincides with a Russian Soyuz flight in late April. The station's international partners are considering sending a two-person crew that would include an American up on a Soyuz capsule to relieve the station crew, which has been in orbit since November. That scenario is just one under consideration, NASA spokesman Rob Navias said. The United States would not fund the mission, since the Russians were launching the Soyuz anyway as part of its ISS commitments, he said. ["Station crew likely to stay 2-4 months," **Florida Today**, February 12, 2003, p 4A.]

February 12: NASA Administrator Sean O'Keefe moved late Wednesday to quell criticism of a commission investigating the Columbia disaster by giving it more independence. Earlier in the day, during the first in a series of congressional hearings on the Columbia disaster, O'Keefe came under fire from Republicans and Democrats for creating an investigating panel with too many ties to NASA and its leader. Hours after he testified before a joint meeting of the Senate Commerce and House Science committees, O'Keefe agreed to let the commission, led by retired Adm. Harold W. Gehman Jr., set its own policies and decide how to release its results, instead of working through the National Aeronautics and Space Administration. "NASA will do whatever it takes to ensure the integrity of the Gehman board as it works to identify the cause of this horrific accident," O'Keefe said. Lawmakers had complained that the commission's report would be sent to NASA instead of directly to the public and that the board needed NASA approval for its policies. Web posted. (2003). [O'Keefe makes probe more independent [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, February 13].]

◆ NASA has released transcripts from some of space shuttle Columbia's final radio transmissions, chronicling the efforts of Mission Control engineers as they became painfully aware of the destruction that was unfolding. In the conversations, released Tuesday, Mission Control reports a litany of problems that seem to worsen by the minute as the shuttle breaks into pieces, killing all seven astronauts aboard. The first bad news came when Jeff Kling, the maintenance, mechanical arm and crew systems officer, reported a sudden and unexplained loss of data from spacecraft sensors. The assessment came in the final six or seven minutes of the flight. "I just lost four separate temperature transducers on the left side of the vehicle, the hydraulic return temperatures," Kling said. Flight director Leroy Cain quickly asked if there was anything common to the sensors and got bad news in reply. Kling said there was no commonality, suggesting there was a general failure instead of a single system. Moments later, more bad news. Mike Sarafin, the guidance and navigation officer, announces Columbia's wing is encountering drag, or increased wind resistance. Cain, still hopeful, asks if everything else is normal and Sarafin assures him, "I don't see anything out of the ordinary." There is a short indistinct call from the spacecraft and, almost at the same time, Kling says the landing gear tires have lost pressure. Capsule communicator Charlie Hobaugh then addresses the spacecraft: "And Columbia, Houston, we see your tire pressure messages and we did not copy your last. Columbia Commander Rick Husband's response -- "Roger, huh ..." -- is abruptly cut off. It is 8:59 a.m. EST (1359 GMT). In short order, flight controllers begin reporting a string of more problems. There is evidence of small collisions on the tail, and signals are cut off from the nose landing gear and the

right main landing gear. Then more sensors are lost and the drag increases to the left. Hobbaugh begins a series of radio calls to Columbia. There is no response as the minutes tick down toward a planned landing at the Kennedy Space Center. "MILA (the Kennedy spacecraft communication center) is not reporting any RF (radio frequency) at this time," says Bill Foster, a ground controller. "OK," says Cain, who then asks hopefully when a radar signal was expected. "One minute ago, flight," comes the response from Richard Jones, flight dynamics officer. The communication checks continue. So does the silence. A radar station near the Kennedy center then says it is putting its radar in a 'search mode.' "We do not have any valid data at this time," said Jones. He said there was a "blip" but it was bad data. Then a long pause, a silence of despair. Then Cain says the final words, the phrase that marked the lack of hope: "Lock the doors." This meant nobody could leave Mission Control or even make phone calls. For the next several hours, the engineers have to ignore the certain loss of the crew and store the data in their computers, finish reports and then write personal accounts of what they saw, heard and did Feb. 1. Web posted. (2003). [NASA Releases Tape of Final Mission Talk [Online]. Available WWW: <http://www.space.com/> [2003, February 12].]

◆ A NASA engineer weighed the possibility of a "catastrophic" failure resulting from extreme heat on the shuttle Columbia's tires despite assurances days earlier that possible damage to insulating tiles near the landing gear wouldn't imperil the crew. In internal e-mails released by NASA on Wednesday, one safety engineer, Robert H. Daugherty, warned that extreme temperatures during a fiery descent could cause the wheel to fail and the tire to burst inside Columbia's wheel well. "It seems to me that with that much carnage in the wheel well, something could get screwed up enough to prevent deployment and then you are in a world of hurt," Daugherty wrote to officials at Johnson Space Center. He added that such an internal blast "would almost certainly blow the door off the hinges or at least send it out into the slip stream -- catastrophic." Daugherty acknowledged his concerns were "over the top in many ways," but added that, "this is a pretty bad time to get surprised and have to make decisions in the last 20 minutes." He cautioned in his e-mail, "I am admittedly erring way on the side of absolute worst-case scenarios, and I don't really believe things are as bad as I'm getting ready to make them out." Since Columbia's breakup over Texas, senior NASA officials have expressed repeated confidence in conclusions by engineers at The Boeing Co., its contractor, that the shuttle could return safely despite the risks of damage to delicate thermal tiles on its left wing that might have occurred on liftoff. In a congressional hearing Wednesday, NASA Administrator Sean O'Keefe told lawmakers that during the 16-day mission, the space agency had no indications that would suggest a compromise to flight safety. An internal assessment by Boeing experts on January 23 -- seven days after liftoff -- predicted "safe return indicated," even if the foam insulation that fell from Columbia's external fuel tank had caused "significant tile damage." But NASA confirms that officials from the Space Center called experts January 27 -- four days later -- at its Langley research facility in Hampton, Virginia, to ask what might happen if the shuttle's tires were not inflated when it attempted to land. Web posted. (2003). [NASA had worried about tire failure [Online]. Available WWW: <http://www.cnn.com/> [2003, February 12].]

◆ The first pieces of the U. S. space shuttle Columbia arrived home at Kennedy Space Center on Wednesday, 11 days after a catastrophic accident caused it to break up while reentering Earth's atmosphere. Two unmarked trucks drove through the gates at Kennedy about 9 a.m. with the first of some 15,000 pieces of the shuttle collected from a debris field that extended from Fort Worth, Texas, east to the Louisiana border. Wing segments, a landing gear, a number of spherical fuel tanks and other debris were unloaded into a shuttle hangar with more than an acre of floor space. The floor had already been marked off by blue tape to receive the pieces and arrange them in something that resembled the configuration in which Columbia flew. At the same time, members of the independent investigation board led by retired Adm. Harold Gehman arrived to begin work there. Web posted. (2003). [First pieces of shuttle Columbia arrive in Florida [Online]. Available WWW: <http://www.alertnet.org/> [2003, February 12].]

◆ Gathered in an empty hangar, a crew of several dozen workers sorted and cataloged the shuttle debris in silence Wednesday, passing repeatedly under a banner bearing the words "We're behind you, Columbia." They walked along the edges of an assembly area -- measuring 188 feet by 166 feet -- marked off on the hangar floor, empty save for a dozen or so orange traffic cones telling workers where to put things. Resting on each cone was a small white placard, bearing labels that included: Crew Module, Right Wing Lower, Right Wing Tiles, Outboard Elevon RH. This was the crew's first day in what is expected to be a months long process at Kennedy Space Center in which investigators will take more than 12,000 pieces, collected

by search crews in Texas and Louisiana, and spread them across the floor of hangar J6-2466 in a quest to figure out why. ["Shuttle workers are crucial to Columbia reconstruction," **Orlando Sentinel**, February 13, 2003, p A19.]

February 13: NASA is still seeking help from the American public to supply video and still images of the Space Shuttle Columbia on its return flight to Earth. There has been a great public response, but more material will help the investigation of the Columbia accident. Columbia glided across the western U.S. just before sunrise Saturday, February 1. The Shuttle flew just north of San Francisco around 6:50 a.m. PST and broke up over eastern Texas around 8:00 a.m. CST. Any imagery, especially video, of the Shuttle's path might aid the Columbia Accident Investigation Board in determining the cause of the accident. Media and private citizens who have video or still images of Columbia's entry path are encouraged to send it to investigators. ["NASA seeks help from sky watchers," **NASA News Release #n03-017**, February 13, 2003.]

◆ Preliminary analysis by a NASA working group this week indicates that the temperature indications seen in Columbia's left wheel well during entry would require the presence of plasma (super heated gas surrounding the orbiter during re-entry). Heat transfer through the structure as from a missing tile would not be sufficient to cause the temperature indications seen in the last minutes of flight. Additional analysis is underway, looking at various scenarios in which a breach of some type, allowing plasma into the wheel well area or elsewhere in the wing, could occur. Other flight data including gear position indicators and drag information does not support the scenario of an early deployment of the left gear. The search continues for possible debris from Columbia in the western U.S., but as of early Thursday, no debris further west than Ft. Worth, Texas has been confirmed as Shuttle-related. ["Statement by the Columbia Accident Investigation Board: Thermal Analysis Shows Hot Plasma Possible in Columbia Left Wheel Well Area," **NASA News Release #03-072**, February 13, 2003.]

◆ The remains of all seven members of Space Shuttle Columbia's crew have been positively identified at Dover Air Force Base, Del. "We are comforted by the knowledge we have brought our seven friends home," said Bob Cabana, Director of Flight Crew Operations at the Johnson Space Center. "We are deeply indebted to the communities and volunteers who made this homecoming possible, and brought peace of mind to the crew's families, and the entire NASA family," he said. The seven astronauts, Rick Husband (Colonel, USAF), Willie McCool (Commander, USN), Michael Anderson (Lieutenant Colonel, USAF), David Brown (Captain, USN), Kalpana Chawla, Laurel Clark (Commander, USN), and Ilan Ramon (Colonel, Israel Air Force), died Saturday, Feb. 1, 2003, when the Space Shuttle Columbia broke up over the southwest United States. Private memorial services for the crewmembers will take place within the next few weeks. Burial services for Ilan Ramon took place February 11 in Israel. ["Columbia Astronaut Remains Identified," **NASA News Release #03-070**, February 13, 2003.]

◆ While the Columbia investigation board continued its tour of Kennedy Space Center on Thursday, shuttle program manager Ron Dittmore paid a visit, too. Dittmore met and spoke with KSC shuttle workers and got a look at Endeavour, which is in the orbiter processing facility getting ready for its next flight. He also went to the hangar at the Shuttle Landing Facility where Columbia debris is being assembled. Dittmore is touring several NASA centers in the wake of the Feb. 1 accident that killed Columbia's crew of seven. After the accident, he gave detailed briefings to the press, but now all information is being released with the approval of the investigation board. The board, headed by retired Navy Adm. Harold Gehman, split up Thursday to look at facilities including a shuttle launch pad and the shuttle logistics depot, where parts are stored. Mike Leinbach, a veteran launch director now named Columbia reconstruction project manager, showed the members around the reusable launch vehicle hangar, where several pieces of debris have been placed on the reconstruction grid on the floor. The board discussed how to process debris while protecting not only evidence, but workers, who might be dealing with potentially hazardous materials. ["Investigation board, Dittmore tour KSC," **Florida Today**, February 14, 2003, p 4A.]

February 15: It's a photo that's been viewed by millions -- a small white puff coming off the left underbelly of the space shuttle Columbia 82 seconds after it lifted off the launch pad. The puff was a doormat-sized piece of foam that had peeled off the external fuel tank and caromed off the orbiter at nearly

500 mph. It could be the key to what caused Columbia to break into pieces in a fiery streak across the sky when it tried to return to Earth two weeks later. But the government camera in the best position to record the damage was out of focus and had been for weeks. Now, the two companies that operate the camera -- the ones to blame for the blurry photo -- either won't talk about it or blame the other partner. The camera is operated by Johnson Controls Inc., which is based in Milwaukee. Company spokesman Darryll L. Fortune said the camera worked fine. What failed, he said, was a 400-inch focal-length telescopic lens operated and maintained by Computer Services Raytheon. Officials with that company would not comment. Vice President Francis Shill in Cape Canaveral referred calls to a corporate spokesman, Mike Dickerson in El Segundo, Calif., who on Thursday would not comment. The Air Force, the owner of the equipment, agrees the problem was with the lens. ["Fuzzy shuttle image fuels dispute," **Orlando Sentinel**, February 15, 2003, p A16.]

◆ Pieces from Columbia's left side, where a cascade of failures preceded the orbiter's destruction Feb. 1, are among those now finding a place on the reconstruction grid at Kennedy Space Center. In the Reusable Launch Vehicle hangar at the Shuttle Landing Facility, workers Friday were labeling and placing pieces within outlines of the fuselage structure, lower fuselage tiles, three layers of each wing and other parts. The debris is brought into the hangar after passing through a washing area outside. The pieces are examined, labeled and numbered before they are laid out on the grid. Some debris still is in U-Haul boxes. The smallest pieces are put in clear plastic bags and then in bins. Larger pieces, however, evoke memories of the ship Columbia once was: the outer ring of a hatch; a fragment of frame from the windows where the astronauts loved to gaze upon the Earth. Placed in outlines that denote layers of the left wing were a main landing gear strut, a shaft that activates the rear elevon, part of a tire and part of the reaction control system. The Columbia Accident Investigation Board left Kennedy Space Center on Friday morning with a promise to return as early as next week to continue its work. "We are becoming aware of the size of the job," retired Navy Adm. Harold Gehman, the chairman of the board, told reporters at the shuttle landing strip while the board's plane prepared to depart for Marshall Space Flight Center. Because of the enormity of the task and the need for more expertise, Gehman said the board likely will be expanded by one or two people. The board is divided into three subgroups. At least some members are expected to come back next week to follow up on technical discussions with workers involved in everything from materials to launches. The investigators toured several facilities while they were at KSC, looking at all three remaining orbiters. Atlantis is stacked with its boosters and external tank and is ready for rollout in the Vehicle Assembly Building, while Discovery is undergoing a long-term overhaul and Endeavour is preparing for a future flight. No flights are scheduled until the investigation is complete. "We wanted to see every rivet and every joint, every wire and every sensor," Gehman said. The investigators want to be able to visualize the parts they've seen only on blueprints in Houston, Gehman said, particularly the shuttle's left wing. Citing privacy concerns, he wouldn't comment in detail on how the astronauts' remains -- which have been positively identified at Dover Air Force Base in Delaware, NASA announced Thursday -- will configure in the investigation. They are yielding evidence, he said. "They are being scrutinized very carefully and segregated from the rest of the debris," Gehman said. He said board members approved the process for handling debris from Columbia, which disintegrated over Texas while trying to land Feb. 1. The investigators want specific tests performed on the pieces. One concern in the investigation is the impact of a piece of external-tank insulating foam on the left wing's tiles during launch. NASA has a large body of tests that already address the impact of foam on tiles, Gehman said, but the board could order more once it sees more evidence. "This will depend on how much tile we collect," he said. "The little bit of tile we have picked up so far is unremarkable," Gehman said. Meanwhile, NASA announced it will expand the board by three members amid calls on Capitol Hill for President Bush to appoint a new panel to take over the probe and report directly to him and Congress. Sheila Widnall, a Massachusetts Institute of Technology aerospace scientist and secretary of the Air Force during the Clinton administration, is one of the three new members who will be formally announced early next week, according to congressional sources. Widnall confirmed Friday that she was joining the commission. Gehman told reporters that he intends to add experts in areas including high altitude aerodynamics and thermal engineering and civilian government contracting. ["Debris dots daunting grid," **Florida Today**, February 15, 2003, p 1A & 6A.]

◆ The space shuttle Columbia fought to stabilize itself after losing contact with controllers on the ground, NASA investigators said yesterday. Two control jets fired after Mission Control lost contact with the shuttle, indicating that Columbia was plummeting out of control for as long as 15 to 20 seconds

between the loss of contact with flight controllers and the shuttle's breakup, NASA investigators said. The last voice communication from the shuttle's seven astronauts came as Columbia streaked across New Mexico on Feb. 1. It is not clear whether the new information will help in the search for the cause of the accident, but it means the seven astronauts may have had longer to understand what was happening. The new information comes from 32 seconds of "junk" telemetry data that were transmitted after voice contact was lost. The data were automatically discarded by NASA's computers as "junk." NASA program officials had said efforts to recover the data were proving more difficult than anticipated. Asked about the "junk" data as he left New Orleans yesterday, retired Adm. Harold W. Gehman Jr., chairman of a panel investigating the disaster, said "it's too early" to assess its meaning. A spokesman for the panel said he was not aware that any conclusions had been reached about what the astronauts knew after losing contact with controllers. The news came as NASA investigators also found a single tile 20 miles west of Fort Worth yesterday, possibly providing insight into the early stages of the spacecraft's disintegration. Most wreckage from the shuttle has been found in east Texas, primarily in rural Sabine and Nacogdoches counties, but investigators have said pieces found farther west could provide evidence of what happened at the beginning of Columbia's breakup. "It tends to confirm the visual evidence that we have that the orbiter was shedding things before it got into the Fort Worth area," Gehman said. "We have been looking hard, and this encourages us to look harder." "We will look at it [the tile] and see if it holds any clues," said Steve Nesbitt, spokesman for the accident investigation board headed by Gehman. The discovery was not a complete surprise to NASA investigators. The search for possible wreckage in a two-square-mile area in the Sandia Mountains of New Mexico turned up a beer can and sardine can, neither from the shuttle. Residents had reported hearing a sonic boom and other noise indicating that wreckage might have fallen in the area. Web posted. (2003). [Data Shed New Light On Shuttle Maneuvers [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, February 16].]

FEBRUARY 16: Engineers are studying a thermal seal on shuttle Columbia's left landing-gear door and a possible hole in the left wing's leading edge as the most likely places where superhot gases could have breached the doomed ship during entry. Internal documents obtained from NASA's Space Shuttle Vehicle Engineering Office confirm investigators are focusing on those two areas to learn why Columbia broke up over central Texas on Feb. 1, killing seven astronauts. Last week, NASA determined that hot gases, called plasma, had not broken through the shuttle's thermal-protection system somewhere to cause the 30 to 40 degree heat spike detected by sensors in the left landing gear's wheel well. "The wing's leading edge may be the more likely candidate," a Johnson Space Center manager close to the investigation said. "If there was direct plasma flow into the wheel-well box, the wheel well might have heated up faster than it did." Vents are scattered throughout the inside of the wing structure to allow airflow and relieve pressure. One such opening could let air move from inside the forward area of the wing back into the wheel well. Another vent leads from the wing into the fuselage. Some NASA investigators theorize that the blow-torchlike gases followed the airflow paths inside the wing, passing through vents, heating surfaces and eventually eroding the shuttle's wing structure from within. ["NASA looks at 2 spots for breach," **Orlando Sentinel**, February 17, 2003, p A1 & A15.]

◆ Volunteers looking for debris from shuttle Columbia abandoned the Embudito Canyon in New Mexico on Sunday after searching a 2-square-mile region of boulders and cacti and finding nothing. NASA continues to investigate debris reports in New Mexico and other Western states, but no large-scale ground searches are planned for now, officials said. ["New Mexico debris search turns up nothing," **Orlando Sentinel**, February 17, 2003, p A15.]

◆ The picture taken of shuttle Columbia as it flew over New Mexico upon re-entry was actually captured with a small telescope favored by amateur astronomers, a digital camera and a pair of flat mirrors used by the U.S. Air Force. In the early morning of Feb. 1 as Columbia pointed itself toward the Kennedy Space Center landing strip, Air Force researchers intended to test data that NASA had given them a few hours before that required pointing their Questar telescope, with a 3.5 inch aperture, along a track that NASA had predicted. This was the first time the Air Force Research Laboratory at Kirtland Air Force Base outside of Albuquerque, N.M. had tried this. Their predictions were slightly off. They only got one picture because they had to keep readjusting the mirrors. ["Telescope caught single image," **Florida Today**, February 17, 2003, p 1A & 5A.]

February 17: Recordings made by instruments sensitive to sound below the threshold of human hearing may help investigators build a timeline of any uncharacteristic movements made by the space shuttle Columbia minutes before it broke apart, scientists say. The instruments also captured an explosion high over Texas that one scientist said could have been Columbia's cabin rupturing. As parts of Columbia began to break off as the shuttle streaked across the West, the flight behavior of the normally streamlined spacecraft would have changed. Those changes would have generated distinctly different patterns of sound waves compared to previous shuttle flights. The patterns, recorded on the ground by instruments in Texas, Nevada and elsewhere in the West, are now being examined as part of the Columbia disaster investigation. Any abnormal patterns can help investigators establish the timing of events as the shuttle entered the Earth's atmosphere February 1, said Keith Koper, a geophysicist at Saint Louis University in Missouri. Investigators already know from sensor data sent from the shuttle in its final minutes -- supported by eyewitness reports, photographs and video footage -- that Columbia's cascade of problems began while the spacecraft was still over the Pacific Ocean. The sensors indicated increasing heat as well as increased drag on shuttle's left wing, suggesting it was somehow damaged, perhaps from the impact of a chunk of hard foam that broke off the external fuel tank and hit the wing shortly after liftoff Jan. 16. Investigators have said they suspect that data means Columbia was already dropping debris over the West, several minutes and hundreds of miles before it broke apart high over Texas. Web posted. (2003). [Low sound waves to help Columbia investigators [Online]. Available WWW: <http://www.cnn.com/> [2003, February 17].]

◆ In a report to his bosses 17 months ago, space shuttle program manager Ronald D. Dittemore expressed concern that the unconventional public-private partnership entrusted with overseeing shuttle missions was nearing a breaking point. NASA was losing key staffers, those with engineering and other technical skills. Meanwhile, more responsibility was being handed over to a single prime contractor, United Space Alliance. Dittemore worried NASA was becoming too dependent on a company that it was unable to properly oversee. "A different approach is required to sustain safe and successful operations for the next 20 years," he wrote in the Sept. 28, 2001, report. His concerns, and similar ones raised by the General Accounting Office, NASA's own Aerospace Safety Advisory Panel and inspector general's office, were bolstered by a number of close calls in recent years. On at least three occasions since 1999, the liftoff countdown was stopped within days or hours of launch to recheck such things as paperwork and possible wiring and other problems. In June 2002, a contract engineer discovered what NASA deemed "potentially catastrophic" hairline cracks along some fuel lines, grounding the entire fleet for months. Among the missions that were delayed was Columbia's ill-fated last, STS-107. The power-sharing relationship that Dittemore found so problematic is still in place, and with the Feb. 1 space shuttle tragedy, the safety implications about how NASA has privatized its operations, along with the staff and budget cuts that have gone with it, remains one of the most troubling questions facing space agency administrators. Under a management structure set up a little over six years ago, United Space Alliance, a partnership between Lockheed Martin Corp. and Boeing Co., handles much of the day-to-day operations, with NASA input and supervision. NASA may hire the astronauts, but at Johnson Space Center here, the contractors are in charge of training the crew and drawing up flight plans. The contractors also dominate mission control, though the flight directors and the "capcom" who talks to the crew in space are NASA employees. At Kennedy Space Center in Florida, the shuttle and its launch facilities are owned by the federal government, and the government has indemnified the contractor in the event of accidents. But it is corporate workers who maintain and upgrade the shuttle, monitored by a limited group of NASA quality control inspectors. It is a system built on trust that the government says has streamlined the launch process, allowing NASA's 1,700 civil servants to concentrate on such things as general mission planning and administration and its more than 17,000 contractors on more routine, mechanical tasks. NASA also relies on tens of thousands of subcontractors. The disproportionately large contract workforce has meant that NASA has had to resort to what it calls "insight" rather than "oversight" in managing its army of private industry employees. Practically speaking, that means NASA mostly sets safety standards rather than being a constant physical presence looking over a technician's shoulder on the repair shop floor, or redoing analyses by contractor engineers. NASA and United Space Alliance have boasted about privatization's successes -- that they have not only cut staff and costs but managed to increase several measures of safety at the same time. The average number of in-flight problems, or anomalies, fell to six per flight in 1997-2002 from 20 per flight in 1988-1991. And the probability of catastrophic loss, a number that takes into account a variety of safety factors, fell to 1 in 438 in 1999 from 1 in 78 in 1992. "All of the measures show quality and safety are better today than ever in the history of the program," said Michael McCulley, a former shuttle pilot who is

chief operating officer of United Space Alliance. Web posted. (2003). [At NASA, Concerns on Contractors [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, February 17].]

◆ The space shuttle Columbia's last major overhaul -- the largest in the history of the program -- involved some components and systems now under suspicion in the investigation into the orbiter's final, disastrous descent. No evidence has emerged linking the work performed on Columbia during the 17-month refurbishment to the shuttle's breakup February 1. Columbia flew one successful mission after the overhaul was completed in 2001. However, inspection and work records from that overhaul at the Boeing Co. plant where the shuttle was built in Palmdale, California, may hold clues. Among the modifications to NASA's oldest shuttle were increased protection from space debris and enhanced heat protection for the leading edges of the wings. According to NASA, the spacecraft's aluminum frame also was closely inspected for signs of fatigue or corrosion. It's not clear, and NASA officials could not immediately say, what was found and how much repair work took place. The shuttle's first layer of protection, the fragile reinforced carbon tiles, also were closely inspected and repaired or replaced where necessary. Disaster investigators have said they believe a hole or gash allowed superheated gases to penetrate Columbia as it entered Earth's atmosphere. They don't believe overheating detected in the left wing before the breakup could have been caused simply by the loss of tiles. Other possible causes include space debris or the impact of a piece of hard insulation that broke off the external tank shortly after launch. Web posted. (2003). [Columbia's final overhaul included increased thermal protection [Online]. Available WWW: <http://www.cnn.com/> [2003, February 17].]

FEBRUARY 18: The NASA charter for the independent panel in charge of the Space Shuttle Columbia accident investigation has been amended. The changes allow the Space Shuttle accident investigation board additional flexibility in acquiring support staff and expertise outside of NASA. NASA Administrator Sean O'Keefe has indicated the charter will continue to be updated as necessary to ensure the panel, which is known as the Gehman Board, remains independent during the course of the investigation. On Saturday, Admiral Harold W. Gehman, Jr., announced the addition of Dr. Shelia Widnall of the Massachusetts Institute of Technology, Cambridge, Mass., to the panel. Dr. Widnall, former Secretary of the Air Force from 1993 to 1997, is a world-renowned expert in aircraft turbulence and spiraling airflows. She will begin meeting with the other members of the Gehman Board Thursday, Feb. 20, in Houston. An updated copy of the board's charter and letter from the NASA Administrator is on the Internet at www.nasa.gov. ["Space Shuttle Accident Investigation Board Charter Amended," **NASA News Release #N03-019**, February 18, 2003.]

◆ A public poll carried out a week after the Columbia disaster finds widespread backing in America for the NASA program. Support for NASA shuttle flights remains firm, the poll indicates, with three in four citizens wanting the space agency's funding level to be maintained or increased. Support for NASA funding was found to be somewhat higher than what was measured 3 years ago. A slim majority of Americans favor a continued focus on human rather than robotic missions. The poll also shows that about three in ten Americans would themselves like to take a space shuttle flight sometime in the future, slightly fewer than wanted to be a shuttle passenger 12 years ago. The Gallup Organization of Princeton, New Jersey carried out the poll in concert with CNN and USA Today, with the results released February 17. "After the crash of the shuttle Columbia, many critics argued that the NASA space program was wasting money and lives by focusing on manned flight, when unmanned missions were more cost-effective and did not put human lives in danger," noted David Moore of the Gallup News Service. "But this argument has not been widely discussed in the news, and for the most part, Americans lean more to what NASA has been doing. By 52% to 37%, Americans prefer NASA's focus on manned rather than unmanned missions, not much changed from a [Gallup poll] reading in November 1998," Moore reported. Other poll results show a public wanting NASA to stay the course. Twenty-five percent of Americans would like funding for the U.S. space program increased and another 49% would like it maintained at current levels. About one in four Americans (24%) prefer decreased spending, including 7% who say spending should be ended altogether. Women tend to be less supportive of NASA's piloted space missions, than are men. While men support increasing over decreasing spending for NASA by 31% to 21%, women take the opposite tack by 28% to 19%. For both groups, about half say spending should remain the same. Why do women prefer automated over human space missions? According to the Gallup poll, the difference is due primarily to older women, among whom a majority support unpiloted over human missions. Majorities of younger

women and of both younger and older men opt for the human missions. With the tragic end to Columbia in their mind, those citizens polled were asked about future space passenger flight. About three in ten Americans would like to take a space shuttle flight at some time in the future. This number is just slightly below the 34% who expressed this desire in 1991, and the 38% who said that shortly following the 1986 Challenger explosion. Men are much more likely than women to want such an adventure, as are younger more than older people. Both younger and older men are more likely to say they want to take a flight than are the comparable groups of women. But clearly, as people get older, the appeal of space flight diminishes -- despite the fact that former Senator John Glenn flew on a shuttle flight in 1998 at age 77. The latest Gallup results are based on telephone interviews with 1,000 national adults, aged 18 and older, conducted Feb. 7-9, shortly after the Columbia catastrophe. For results based on the total sample of national adults, Gallup officials said, one can say with 95% confidence that the margin of sampling error is ± 3 percentage points. In addition to sampling error, question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of public opinion polls. Web posted. (2003). [Poll: Despite Accident, Support for NASA Still High [Online]. Available WWW: <http://www.space.com/> [2003, February 18].]

◆ Unseen defects that cause orange foam to fall off the external tank could be spotted and repaired before launch using a laser technology NASA has studied for a decade but never made part of its shuttle inspections. Reports show that beginning in 1994, and possibly earlier, NASA engineers believed a process called laser shearography "will reduce, if not eliminate the problems of debonding" of foam from the tank. The Boeing Co. uses the technique to inspect similar foam insulation on its Delta 4 rockets launched from Cape Canaveral. Investigators are trying to determine whether a briefcase-sized chunk of foam falling from the external tank damaged Columbia's wing or heat shield, opening a path for superhot gas to flow into and destroy the ship as it flew home to Earth on Feb. 1. "Reliable detection of flaws on the external tank and solid rocket booster contributes not only to cost savings but also to the safety of those who fly aboard the space shuttle," Kennedy Space Center engineer Chris Davis wrote in one report on the project. Davis has recommended several times since the mid-1990s that the laser shearography technique become part of the normal processing of the space shuttle before launch. Now, NASA relies on visual inspections that simply can't detect tiny cracks, air pockets and weakened bonds hidden beneath the surface of the inch-thick layer of hardened foam. The most recent report said NASA would develop implementation plans for the technology as early as 2001, but as of this past mission, it had not become part of shuttle processing. Davis' team reported near-perfect results with tests using the lasers. At the Michoud, La., facility where the tanks are made by Lockheed Martin, company spokesman Harry Wadsworth said the shearography technique was not used because it is not reliable and produced false positives. "In other words, when it is OK, sometimes it tells us it's not OK. It indicates flaws where none exists sometimes," he said. Foam shedding from the tank is something NASA has wrestled with since Columbia's maiden voyage back in 1981. ["Foam test neglected," **Florida Today**, February 19, 2003, p 1A & 2A.]

◆ Pieces were likely coming off Columbia as the shuttle approached the California coast during its re-entry Feb. 1, but the debris may have burned up in the atmosphere, an investigator said. Film evidence suggests pieces were coming off at that time, James Hallock of the Columbia Accident Investigation Board said. He is working with the subgroup of the board dealing with technical analysis of the accident from launch through the ship's disintegration over Texas. "Obviously, it's very important to understand what those pieces are," Hallock said at a press briefing at Johnson Space Center, because they came off at the start of the orbiter's troubles that morning. NASA is asking ranchers as far west as California to keep an eye out for debris, and more than 2,000 workers are combing Nacogdoches, Hemphill and Palestine, Texas, according to the Federal Emergency Management Agency. The investigative board has dispatched a representative to Kennedy Space Center to take photos of debris being assembled at the Reusable Launch Vehicle hangar by the shuttle landing strip. Investigators are looking for any visual clues. "If there really was superheating," Hallock said, "then we should probably find issues of small droplets of metal." It's not clear whether the main landing gear strut at KSC is from the left or right side of the orbiter, board chairman Hal Gehman said. Investigators will take it apart bit by bit to try to identify it. About 2,600 of the 4,000 pieces at KSC have been identified, said Gehman, a retired Navy admiral. About 10,000 additional pieces have been found. ["Shuttle lost some parts over Calif.," **Florida Today**, February 19, 2003, p 2A.]

◆ On February 18, 2003, Special Agents from the NASA Office of the Inspector General, working with agents from the U.S. Border Patrol, arrested four alleged illegal immigrants working as contractor employees inside a restricted area at the Kennedy Space Center/Cape Canaveral Air Force Station. The U.S. Immigration and Naturalization Service will hold the alleged illegal aliens pending positive identification and subsequent deportation proceedings. Assistant U.S. Attorney Roberta Tylke is handling the case for the U.S. Attorney's Office, Middle District of Florida. ["Four Alleged Illegal Aliens Arrested At NASA Kennedy Space Center," **Office of Inspector General News Release #2003-021**, March 4, 2003.]

FEBRUARY 19: NASA is asking citizens and officials in Arizona, Nevada, New Mexico, and Utah for help to find material from the Space Shuttle Columbia. The material would have fallen from the Shuttle as it was reentering Earth's atmosphere along a line stretching generally from San Francisco to Lafayette, La. Everyone is asked to be on the lookout for possible Shuttle material 60 miles north or south of the reentry track, particularly in the following counties: Arizona: Apache, Navajo, Coconino, Mohave; Nevada: Lincoln; New Mexico: San Juan, Kane, Beaver; and Utah: Washington, Iron, San Juan, Garfield. Anyone who finds material, suspected to be from the Shuttle, is urged to avoid contact, because it may be hazardous due to fuel residue. ["NASA Asks For Help In Arizona, Nevada, New Mexico & Utah," **NASA News Release #n03-21**, February 19, 2003.]

◆ The military agency that tracks orbiting satellites and space debris with radar located an object receding quickly from the shuttle Columbia about a day after it launched, NASA says. The object could be space debris, a small meteor, a piece of the shuttle that had dislodged or nothing more than ice formed by discharged wastewater. "At this point, we don't know what it is," said Eileen Hawley, a space agency spokeswoman. "We're just beginning to analyze the data, and eventually it will go to the investigative board." The Columbia Accident Investigation Board will examine the mission timeline to determine what activities were under way on the shuttle at the time and whether the astronauts reported anything amiss, said Hawley. They also will look at data from shuttle instruments that might indicate a vibration or other change. As part of its tracking responsibilities, the North American Aerospace Defense Command at Peterson Air Force Base, Colo., watches for orbital debris threats to the shuttles and the international space station. If the radar suggests a collision with debris is possible, the astronauts maneuver the craft to avoid it. Web posted. (2003). [Object seen falling near shuttle in orbit [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, February 19].]

◆ Searchers found Columbia's nose landing gear next to a large reservoir where divers are looking for more debris, NASA said Wednesday. The piece of debris, which a resident spotted Tuesday next to the Toledo Bend Reservoir on the Texas-Louisiana border, is largely intact. The nose gear piece is about eight feet long. Divers still are looking for what they hope is a large piece that fell into the reservoir Feb. 1, when Columbia broke apart over Texas. Complicating the search is the murky 30-foot-deep water. One tool searchers are using is side-scanning sonar. Divers last found a piece of the shuttle more than a week ago, identified as part of the brake assembly for the orbiter's landing gear. There also is an air search of an area 240 miles by 10 miles and an extensive ground search involving about 3,500 people, spokesman Dave Drachlis said. ["Searchers find nose landing gear intact," **Florida Today**, February 20, 2003, p 1A.]

◆ The orbital space plane, the successor to the shuttle, should be able to make a fast escape from the International Space Station and rescue at least four people, according to new NASA requirements. The vehicle, which could rescue astronauts and provide medical treatment if necessary, would launch on an expendable rocket, according to guidelines announced this week. The system might include multiple vehicles, with rescue capability by 2010 and, by 2012, the ability to take astronauts to and from the station every four to six months. The rescue and transport vehicles are envisioned as different versions of the same basic design. Compared with the shuttle, the new ship should be easier to prepare for flight, the guidelines said, and have "increased launch probability" and "increased on-orbit maneuverability." The space plane would complement the shuttle fleet, NASA deputy administrator Fred Gregory said in announcing the requirements. "This is an important first step in making the Integrated Space Transportation Plan a reality," he said. ["NASA requiring space plane to have transport, rescue ability," **Florida Today**, February 20, 2003, p 2A.]

FEBRUARY 20: The final seconds of flight data from the space shuttle Columbia, transmitted even after contact was lost with Mission Control, indicate that the crew members were likely aware they were in serious trouble. For several days, experts at NASA's Johnson Space Center have been immersed in the highly complex process of reconstructing 32 seconds of data that were recorded by computers in White Sands, N.M., but not displayed on the computer monitors in Mission Control. The data represent the final transmissions from Columbia, which broke up over Texas on Feb. 1, killing all seven astronauts onboard. The remaining three shuttles of NASA's fleet have been grounded during the investigation of the tragedy. Investigators have said Columbia's final readings, transmitted as the shuttle was descending toward a landing in Florida, were so corrupted that NASA's communication system kept them from being displayed at Mission Control. However, new analysis techniques have been used to interpret some of the corrupted data, space analyst James Oberg reported. Bits of data show a leak in the shuttle's Reaction Control System. This system controls a series of small thrusters that were firing furiously in an attempt to stabilize the orbiter. Other readings indicate a pressure drop in the left wing's hydraulic system. Such a scenario would have set off audible alarms in the crew compartment. The last readable part of the White Sands data indicates that Columbia's autopilot was still functioning, Oberg reported, which means the onboard computers were still operating at that point. The corrupted data, which is still being analyzed, show no indication so far of any voice communication from the crew in the final 32 seconds, he said. The data would support the prevailing view that Columbia's troubles began with a breach on the shuttle's left side, but they do not pinpoint the cause of the failure. Web posted. (2003). [Columbia's final readings deciphered [Online]. Available WWW: <http://www.msnbc.com/> [2003, February 20].]

◆ The Columbia Accident Investigation Board (CAIB) Advanced Sightings Team is working to pinpoint the location of hardware that may have separated from the Space Shuttle Columbia early in its final path over the western United States. The team is bringing together data from the National Aeronautics and Space Administration (NASA), the public, Department of Defense (DOD), Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), the United States Geologic Survey (USGS) and all other sources of valuable information that become available. The collaboration of all these organizations has been outstanding. The team is piecing together the information from these sources to learn as much as possible about anomalous conditions during the entry of Columbia. Examples of information that is being brought to bear are: On orbit photography and analysis- DOD; Radar searches- DOD; Infrasonic data- DOE, NOAA; Tracking of possible on orbit object from Columbia 1/17/ 03 and analysis- DOD; Launch Analysis- DOD; Identification of entry shedding events- DOD; Kirtland photo analysis- DOD. This team is analyzing video footage turned in by space flight enthusiasts and other sources of information to document exactly when these events occurred. The earliest shedding of Shuttle hardware may well have been documented by videos taken near the California coast. The team identifies anomalous events from the video data and correlates them to the entry timeline. Analysts calculate the exact time and angles of the observation by determining exactly where the videos were taken from and by identifying planets or star fields in the background. The team calculates trajectories to predict probabilities of where the debris may have fallen to Earth by estimating properties of possible debris from the video and incorporating known atmospheric and wind data. Radar data is then retrieved and investigated to search for specific signatures. This process serves to drastically reduce the area that must be searched. ["CAIB Advanced Sightings Team Status," **NASA News Release #03-078**, February 20, 2003.]

◆ Workers at Kennedy Space Center and other NASA sites are starting tests that might unravel the mystery of what happened to shuttle Columbia's left wing. At Langley Research Center in Hampton, Va., NASA researchers are simulating hypersonic speeds on ceramic space shuttle models to duplicate the drag and intense heating the left wing experienced before Columbia broke apart Feb. 1. "We are responding to a request from Johnson Space Center to do these aeroheating tests," Langley spokesman Keith Henry said. At Kennedy Space Center, chief shuttle contractor United Space Alliance will have a role duplicating what might have happened when insulating foam fell and struck the orbiter's wing during the Jan. 16 launch. A senior official at KSC said there is a conceptual plan, but specifics aren't set. USA workers likely will apply the tiles to a wing structure provided by NASA. The analysis could help to determine how damaging the foam debris was to various areas on Columbia's left wing, an official said. The independent Columbia Accident Investigation Board initiated the effort. Standards for such tests are still being established, Johnson Space Center spokesman James Hartsfield said. Workers at contractor Dynacs at KSC have fired foam at a shuttle tile to test equipment that could be used for a more formal experiment later. The test of the

air cannon, pressurized with nitrogen, wasn't scientific. Researchers aim to accelerate foam to different speeds and hit tiles at various angles to duplicate what Columbia might have experienced. Analysis during the mission by NASA and its contractors used computer models to predict worst-case damage scenarios after cameras spotted a chunk of foam, perhaps the size of a briefcase, striking the left wing. NASA and the accident investigators said that super-hot gas somehow breached the wing days later during re-entry. As they try to determine if the wing was damaged, the foam incident is being revisited. Spokesmen at NASA headquarters and Johnson Space Center said the Dynacs tests are not yet connected with any official investigation of the impact of foam on tiles. ["NASA, KSC begin tile, wing tests," **Florida Today**, February 21, 2003, p 1A & 2A.]

◆ Senate Congressman Dave Weldon got a look at the remains of the shuttle Columbia on Thursday. "It's quite a sobering sight to see the debris," said Weldon, R-Melbourne. The wreckage from Columbia is being brought to a hangar at Kennedy Space Center to be identified and examined. Weldon used to represent the space center, but because of recent redistricting, now represents the area south of KSC, including Cape Canaveral Air Force Station. His district still includes many space workers. Weldon said he supported the external investigation and that a separate presidential commission is probably not necessary so long as the Columbia Accident Investigation Board, led by Adm. Harold Gehman, does a thorough and open investigation. The House and Senate committees that oversee NASA have held joint hearings about the Feb. 1 accident. "I thought it was a little early for Sen. (John) McCain to be holding hearings," Weldon said. He also discussed continuing infrastructure issues at KSC with Center Director Roy Bridges. Weldon said they discussed the leaky roof of the Vehicle Assembly Building, which is the final staging area before the shuttles move out to the launch pads. Pieces of the roof are also falling into work areas, he said. There has been talk around Washington of replacing shuttle Columbia. This could be made difficult since there isn't an ample supply of spare parts for this technology. Weldon said he would be more interested in speeding up development of the Orbital Space Plane, which NASA announced last fall. He added that it would be possible to have the space plane flying in seven years. ["Weldon inspects wreckage," **Florida Today**, February 21, 2003, p 2A.]

FEBRUARY 21: The shuttle Columbia's fuselage remained essentially intact for at least a half minute after the commander's final transmission, according to sources familiar with an ongoing analysis of the last 32 seconds of telemetry from the doomed spacecraft. The astronauts almost certainly had some awareness of the unfolding disaster, but there is no insight at this point to indicate what they might have known, or when. The telemetry data, radioed back to Earth 30 to 32 seconds after normal communications with Columbia were interrupted 207,000 feet above Texas, indicate the shuttle's left wing was either gone or so severely damaged by a catastrophic "burn through" that hydraulic lines leading to the wing's elevons and landing gear had been severed or ruptured. That final burst of telemetry shows the orbiter's hydraulic power units, or APUs, were still functioning, as were the ship's flight computers, navigation systems and its electrical generators. But the data show no pressure in the triply redundant hydraulic power system lines running to the left wing. The hydraulic fluid presumably was being pumped overboard following a structural failure of some sort in the left wing. Whatever happened to Columbia began while the ship was descending over the Pacific Ocean off the west coast of California. Engineers believe hot plasma ate its way into the left wing because of a breach in the shuttle's thermal protection system. The exact location of the breach is not yet known, but engineers are focusing on two areas: The leading edge of the left wing and the left main landing gear door area. In any case, as Columbia's descent continued the plasma burned through wiring, routed around the wheel well, that led to sensors mounted near the rear of the wing. The plasma intrusion also caused temperatures to rise dramatically in the left landing gear wheel well, triggering additional sensor failures. Video and still photography shot by amateurs as far west as California show debris falling away from Columbia as it streaked eastward across the southwestern United States. A team of NASA engineers studying FAA radar tapes has identified at least two possible debris tracks, which are expected to greatly narrow the search area for tiles or other material that might have fallen away from Columbia well before its eventual breakup. Any such debris could prove critical for pinpointing where the plasma breach occurred. Wherever it began, the breach ultimately caused unusual aerodynamic drag to develop on the left side of the spacecraft, forcing Columbia's flight computers to adjust the shuttle's roll trim with the elevons, or wing flaps, on each wing. Eventually, two right-firing rocket thrusters were ignited to provide additional muscle. But it was a losing battle. Shuttle commander Rick Husband, replying to a call from mission control about the loss of tire pressure data from Columbia's left main landing gear, radioed Houston for the last time at

8:59:32 a.m., saying "Roger, uh, (garble)." The transmission was cut off, but Husband's voice did not indicate any apparent alarm. Shuttle program manager Ronald Dittmore said in the days following the mishap that engineers were attempting to extract data from up to 32 seconds of telemetry received on the ground after Husband's final call. The telemetry likely was transmitted continuously during that 32-second period, but line-of-sight communications through NASA's Tracking and Data Relay Satellite were sporadic, possibly because of the shuttle's changing orientation. Analysis of the telemetry that was received is not complete. But officials say valid data continued flowing down for about five seconds after Husband's interrupted transmission. During that five-second period, two more right-firing thrusters ignited on command of Columbia's flight computers, joining the two already in operation to counteract an increasing aerodynamic drag on the left side of the vehicle. Following that initial five seconds of data, there are 25 seconds with no data at all. Then, in a final burst of telemetry between 9:00:02 a.m. and 9:00:04 a.m., data showed Columbia's hydraulic power units were still running. The APUS are located in the aft engine compartment and the fuel cells are under the floor of the cargo bay, showing the fuselage - from the aft compartment to the crew module - was still essentially intact at that point. Analysis shows a "roll reference message" was generated by the ship's flight computers at one point to alert the crew to problems maintaining the shuttle's orientation. Whether that message ever reached a cockpit display is not yet known. Web posted. (2003). [New data shows Columbia's state in final moments [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, February 21].]

◆ Congress and President Bush set aside \$50 million to help NASA pay for its investigation of the shuttle Columbia disaster. President Bush signed an omnibus bill into law Thursday. Congress added the money shortly after the loss of Columbia on Feb. 1. The money may be used to cover the costs of the investigation and also costs related to correcting problems with the shuttle or pay other unforeseen costs. The law recognizes also that costs could exceed the \$50 million and allows for NASA to seek additional funding. The amount was set based on the general cost required to investigate the Challenger disaster of 1986. "We do not have a contingency for this," NASA Comptroller Steve Isakowitz said. "It doesn't represent an estimate from NASA." The overall cost of the investigation is unclear, but three other issues remain in limbo from a budgeting standpoint: The recommendations that come out of the investigation; How the investigation affects the space station program; Whether NASA should build a new shuttle to replace Columbia or build an orbital space plane, which would serve as the follow-on to the shuttle. ["NASA gets \$50 million for shuttle investigation," **Florida Today**, February 22, 2003, p 3A.]

◆ NASA officials confirmed late Friday that a piece of Columbia's tile was found near Lubbock, Texas, the farthest west debris from the space shuttle has been discovered. The piece of tile was found a week ago by a man plowing his field about 40 miles northwest of Lubbock. NASA spokesman Kyle Herring said Friday it was unclear what part of the shuttle the tile came from. Previously, no shuttle debris had been found farther west than Granbury, near Fort Worth and about 300 miles east of Lubbock. ["Debris field moves west," **Florida Today**, February 22, 2003, p 3A.]

◆ Before shuttle Columbia's fatal landing attempt, a NASA engineer complained in e-mails that the agency was not paying more attention to problems that might occur during re-entry if the ship had suffered a breach near its left landing-gear compartment. In a message dated three days before the Feb. 1 disaster, the engineer told a co-worker at NASA's Langley Research Center in Virginia that his efforts to share his concerns were being treated "like the plague." He even suggests that others at NASA's Ames Research Center in Mountain View, Calif., could run landing simulations in secret to see how the shuttle would perform if both tires on its left side were damaged from excess heating. "Since no Orbiter Program Management is 'directing' the sim [simulation] community to do this, it might need to be done 'at night,'" Robert Daugherty wrote in e-mails made public by the National Aeronautics and Space Administration on Friday. In addition to the e-mails, NASA also released three reports that show how the agency analyzed the potential for damage from debris that hit the orbiter's left wing during its Jan. 16 launch. The debris appears to be foam insulation from the outer layer of the shuttle's external tank. NASA now says that Columbia may have been hit by three pieces of debris, though video evidence shows only that two of the chunks actually made contact with the wing. Spokesman James Hartsfield in Houston said it's not clear whether the pieces arose from a single chunk that separated into three, or are three independent segments shed from the same area of the tank. In any case, Hartsfield said the number of pieces does not change the

conclusion of the analysis, which was that any potential damage from the debris would not endanger the ship. ["Engineer sent NASA e-mail on wing risks," **Orlando Sentinel**, February 22, 2003, p A1 & A9.]

FEBRUARY 23: It was 1979, two years before the first space shuttle would roar into space, but Bob Sieck was curious and concerned about what would happen if pieces of Styrofoam-like insulation on the shuttle's main fuel tank broke off as it thundered from its launch pad toward 17,500 mph and orbit. Sieck, who was the shuttle's chief project engineer, thought the flying foam might damage the orbiter's fragile heat-shield tiles. He and a team of can-do engineers decided to find out. They mounted several tiles above the roll bar of the open-wheeled Formula Ford that Sieck raced on weekends. And they hung a desktop-sized slab of foam from a makeshift frame and put it in the middle of a 3-mile-long runway at Kennedy Space Center. Then Sieck ran his car, and the tile, straight at the foam -- at 130 mph. "It was spectacular," Sieck, now retired and living in Titusville, told the Orlando Sentinel. "I'm sure I closed my eyes and gritted my teeth. There was just a 'click' -- and it snowed foam, all over me and all over the car." That snowfall of foam -- and broken pieces of tile -- were the first indicators of a problem that has dogged the National Aeronautics and Space Administration for the 22 years the shuttle has flown: foam breaking free from the shuttle's enormous external fuel tank and damaging the brittle, silicon-based tiles that protect the orbiter from the 2,000-degree-plus heat of re-entry. Ranging from popcorn-sized pellets to chunks the shape of briefcases, moving at relative speeds of as much as 500 mph, debris -- most often falling foam -- has pockmarked and scarred an average of 100 thermal tiles during every one of the shuttle's previous 112 flights -- and sometimes many more tiles than that. Now, investigators fear, as many as three chunks of foam -- perhaps mixed with ice -- slammed into Columbia's underbelly during its Jan. 16 liftoff and may have cracked tiles or damaged the leading edge of the orbiter's left wing. That damage could have allowed superhot gases to get into Columbia's airframe during the fiery heat of re-entry, causing it to break up 207,000 feet over Texas on Feb. 1, killing its crew of seven. The focus on the foam is also prompting a tough look at NASA's decision-making, considering that the space agency has known for more than two decades that the debris posed at least some degree of hazard to its orbiters. ["Foam was 'acceptable risk'," **Orlando Sentinel**, February 23, 2003, p A1 & A18.]

◆ For years before it broke apart in the skies over Texas, the space shuttle Columbia was beset by recurring problems, glitches and close calls. In 20 of its 28 missions, the first in 1981, Columbia experienced mechanical or technical problems at launch or in orbit. Those problems caused Columbia to have more flight delays than any other orbiter, a review of thousands of pages of NASA documents and interviews show. While nobody is yet sure what caused Columbia's catastrophic ending this month, between 1996 and 1999 the orbiter had at least five "escapes" -- a NASA term for a mission that flew with a problem that only "luck or providence" prevented from causing serious damage. On another launch, a worker made what NASA calls a "diving catch," meaning his diligence caught a flaw routine checks had missed. For more than a decade, as inspectors tried to keep Columbia on schedule, they granted waivers from required maintenance, 350 pages worth. Since Columbia was the oldest orbiter in the fleet, NASA also relaxed maintenance standards, an acknowledgment that an old machine cannot perform as well as a newer one. But those changes were made without an assessment about whether the adjustments heightened risk. A safety panel looking at Columbia's wiring problems in 1999 concluded that the issue may have contributed to Columbia's narrowly avoiding an emergency landing. For all the bold thinking that brought forth Columbia, the shuttle program has experienced financial pressure, the loss of skilled workers and maintenance challenges. Numerous outside reviews have concluded there are systemic weaknesses in the shuttle program that go deeper than the mission-by-mission problems. As NASA ponders how to recover from its second shuttle catastrophe in slightly more than 100 flights, it has become clear that manned space flight remains a far riskier undertaking than the program's architects had envisioned. Each of the remaining shuttles -- Discovery, Atlantis and Endeavour -- will face questions about its maintenance record and safety history. NASA is confronting increasing pressure to find a better successor vehicle to the shuttle. NASA staunchly denies safety has slipped, even as outside audits and reviews noted items -- including the hundreds of maintenance waivers or reduction in quality checks -- that point to troubling systemic problems. William F. Readdy, NASA's associate administrator for space flight, said, "I think you would have to look at each of those individually," to understand them, but as a general matter NASA has a safety "culture" that extends from the top down to its smallest vendors. "We are anything but complacent," said NASA Administrator Sean O'Keefe. The care NASA takes in its programs, O'Keefe added, may have

lulled the public into forgetting that space flight is risky. Web posted. (2003). [Columbia Marked by Delay, Faults [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, February 23].]

◆ NASA's budget this year sounds like a lot of money, \$15 billion. But by Washington, D.C. standards, it hardly rises to the level of "real money." In fact, the proposed increase in the Department of Defense budget -- not counting the cost of any war with Iraq -- is about the same size as the space agency's total budget. Adjusted for inflation, NASA's budget is less than half of what it was in the mid-1960s, leaving many wondering if budget cuts have nickel-and-dimed NASA into disaster. "(Safety) could not have helped but to be compromised," said space expert Charles Vick, senior fellow at Globalsecurity.org. When adjusted for inflation, NASA's budget peaked in 1966 at the start of the Apollo program. NASA's budget that year was \$5.9 billion. That is the equivalent of \$32.9 billion in 2002 dollars. NASA's actual budget for 2002 was \$14.3 billion. Measured in 2002 dollars, NASA's budget is even less today than it was in the mid-1990s, when construction of the International Space Station began. Yet while NASA's budget has remained essentially flat in recent years, the agency has had extra responsibility. An example was supporting construction of the space station, which is considered to be the greatest engineering challenge in history. Money otherwise targeted for shuttle operations was diverted to the space station, which is billions of dollars over budget. In 1994, NASA spent \$4.59 billion, adjusted to 2002 dollars, on shuttle operations. By last year, that dropped to \$3.29 billion. One of the biggest critics of NASA's budget cuts has been Sen. Bill Nelson, D-Tallahassee. "They've starved the space shuttle of funds," said Nelson, who as a congressman flew on Columbia in 1986 in the last shuttle mission before the Challenger explosion. "And what they are doing is compromising safety." While NASA may not have had to cut any existing safety programs because of budget constraints, the agency has not been able to make planned safety upgrades to the shuttle fleet. Long before the Columbia disaster, Nelson warned delaying those upgrades was a recipe for a future catastrophe. "I fear that if we don't provide the space shuttle program with the resources it needs for safety upgrades, our country will pay a price we can't bear," he told the Senate Science, Technology and Space Subcommittee in September 2001. "The proposed budget abandons some of the most critical safety upgrades for our aging fleet . . . This budget fails to adequately protect these astronauts." Nothing so far ties the budget cuts to the Columbia disaster and NASA has consistently maintained that safety has not been compromised by the budget cuts. ["NASA must do more with less, **Florida Today**, February 24, 2003, p 1A & 3A.]

◆ Teams searching for parts shed by the space shuttle Columbia as it broke apart found more small metal fragments Sunday in a rural part of southeast Nevada. Digital photographs of the material were sent to NASA's Johnson Space Center in Houston for analysis. Several small scraps of aluminum were also found Saturday. NASA has not confirmed whether any debris west of Texas came from the shuttle. Casey Wood, who was sent by NASA to aid in the search, said he was "80 percent sure the items" were from Columbia. Wood is an employee of NASA contractor United Space Alliance in Cape Canaveral. The board investigating the accident has determined Columbia almost certainly suffered a breach along its wing and possibly its main landing gear compartment that allowed searing air to blast inside during its descent at nearly 12,500 mph. About 80 miles from Panaca in Utah, officials were searching at NASA's request in the Kolob Mountain area near Zion National Park, Washington County Sheriff Kirk Smith said. ["Officials unsure if metal found in Nevada is from Columbia," **Florida Today**, February 24, 2003, p 2A.]

◆ Before Feb. 1, the future of the space shuttle was numbered in decades, as the National Aeronautics and Space Administration estimated the fleet that first lifted off in 1981 easily could keep flying through 2020. With a string of 88 successful missions since the Challenger disaster of 1986 and plans for a replacement shelved indefinitely, the four-orbiter fleet was NASA's present and its future. Then Columbia broke up 200,000 feet above east Texas -- and suddenly NASA was confronted with a question it hadn't expected to face: Should the shuttle fly again? With 2 million parts, it's the most complicated machine ever built; it costs a half-billion dollars per mission and requires 4,000 workers at Kennedy Space Center alone to maintain it. What's more, those per-mission costs are certain to climb. The salaries of those 4,000 workers, as well as the cost of the launch pads and assembly buildings and administrative overhead that sustain it, had been spread across four orbiters. With the loss of Columbia, there are now only three. And its aging technology promises to make upkeep even more expensive at a time when NASA is looking at years of essentially flat budgets. That said, the reality is that NASA has no choice but to keep flying the shuttle. To finish building the \$100 billion International Space Station and to care for its prized \$3 billion

Hubble Space Telescope, NASA must get the remaining fleet back into orbit. NASA's managers, including agency chief Sean O'Keefe, reject assertions that the shuttle program is too expensive or fundamentally unsafe. "I don't know, based on the evidence that's available today and the facts that are arrayed, what would drive us to the conclusion," O'Keefe said last week. "It was very clear that something went deadly wrong [on Columbia], and we're going to find out what that was. "We're going to fix it, and we're going to get back to flying safely as soon as we possibly can." The International Space Station -- the world's only remaining space outpost, orbiting 240 miles above Earth -- is the most urgent reason NASA has for returning to the launch pad. Two Americans and one Russian were expecting shuttle Atlantis to bring a fresh crew to replace them in March. The astronauts and cosmonaut have enough food and supplies to stay on board until June, and they could fly back to Earth if needed on the Russian-made Soyuz capsule that remains parked at the station for emergencies. But NASA -- which is forbidden by Congress to give money to the Russian space agency -- is skeptical about whether the cash-strapped Russians can take over for the shuttle. It seems unlikely that the Russians can take over the arduous job of ferrying crews and supplies back and forth solely on their Soyuz rockets. ["NASA's dilemma: Is shuttle fit to fly?" **Orlando Sentinel**, February 24, 2003, p A1 & A4.]

FEBRUARY 24: NASA and its international partners are nearing a decision on how best to use the Soyuz flight headed to the International Space Station in late April. At issue are dwindling supplies, especially water, and the endurance of the three-man station crew, which was supposed to come home on a shuttle in March. Because the Columbia accident Feb. 1 grounded the shuttle fleet, one possibility is that a caretaker crew of two people would be sent to the station. Such a crew could replace Commander Ken Bowersox, Don Pettit and Nikolai Budarin, who would come home in a Soyuz. "We have several more days' worth of discussions this week with the Russians and international partners," NASA spokesman Rob Navias said Monday at Johnson Space Center. NASA still is looking at supplies aboard the station, how much can be taken up on a scheduled Russian Progress flight in June, and whether another Progress capsule could be pushed ahead of schedule to launch before the end of the year, he said. There's also debate on what to do with the seat the European Space Agency had reserved for Spain's Pedro Duque on the April flight. Several potential candidates trained for the station and Soyuz could go, Navias said. A station crew would have to include one American and one Russian to maintain the U.S. and Russian systems aboard, he said. A Soyuz is always docked with the station as an escape pod. The ships are replaced about every six months. ["NASA works on Soyuz trip issues," **Florida Today**, February 25, 2003, p 1B.]

◆ The first of two Mars Exploration Rovers, MER-1 arrived at the Kennedy Space Center today from the Jet Propulsion Laboratory in Pasadena, Calif. The cruise stage, aeroshell and lander for the Mars Exploration Rover-1 mission also arrived today. This same flight hardware for the MER-2 rover arrived January 27, however this rover is scheduled to arrive at KSC around March 10. The Boeing Delta II vehicle for the first launch of the two launches scheduled on May 25 is planned for erection on the pad at Space Launch Complex 17 beginning April 18. The Delta for the second launch on June 30 will begin erection activities on May 1. Each spacecraft will receive a MER-A or MER-B designation once they arrive at the pad. While at KSC, each of the two rovers, the aeroshells and the landers will undergo a full mission simulation. All of these flight elements will then be integrated together. After spin balance testing, each spacecraft will be mated to a solid propellant upper stage booster that will propel the spacecraft out of Earth orbit. Approximately ten days before launch they will be transported to the launch pad for mating with their respective Boeing Delta II rockets. The rovers will serve as robotic geologists to seek answers about the evolution of Mars, particularly for a history of water. ["First Mars Exploration Rover Arrives At KSC To Begin Preparation For Launch," **NASA News Release #21-03**, February 24, 2003.]

FEBRUARY 25: After more than 30 years, it appears the venerable Pioneer 10 spacecraft has sent its last signal to Earth. Pioneer's last, very weak signal was received on Jan. 22, 2003. NASA engineers report Pioneer 10's radioisotope power source has decayed, and it may not have enough power to send additional transmissions to Earth. NASA's Deep Space Network (DSN) did not detect a signal during the last contact attempt Feb. 7, 2003. The previous three contacts, including the Jan. 22 signal, were very faint with no telemetry received. The last time a Pioneer 10 contact returned telemetry data was April 27, 2002. NASA has no additional contact attempts planned for Pioneer 10. "Pioneer 10 was a pioneer in the true sense of the word. After it passed Mars on its long journey into deep space, it was venturing into places where

nothing built by humanity had ever gone before," said Dr. Colleen Hartman, director of NASA's Solar System Exploration Division, NASA Headquarters, Washington. "It ranks among the most historic as well as the most scientifically rich exploration missions ever undertaken," she said. "Originally designed for a 21-month mission, Pioneer 10 lasted more than 30 years. It was a workhorse that far exceeded its warranty, and I guess you could say we got our money's worth," said Pioneer 10 Project Manager, Dr. Larry Lasher. Pioneer 10 was built by TRW Inc., Redondo Beach, Calif., and was launched March 2, 1972, on a three-stage Atlas-Centaur rocket. Pioneer 10 reached a speed of 32,400 mph needed for the flight to Jupiter, making it the fastest human-made object to leave the Earth; fast enough to pass the moon in 11 hours and to cross Mars' orbit, about 50 million miles away, in just 12 weeks. At last contact, Pioneer 10 was 7.6 billion miles from Earth, or 82 times the nominal distance between the Sun and the Earth. At that distance, it takes more than 11 hours and 20 minutes for the radio signal, traveling at the speed of light, to reach the Earth. ["Pioneer 10 Spacecraft Sends Last Signal," **NASA News Release #03-082**, February 25, 2003.]

◆ In the wake of the Columbia loss, the House Science Committee is planning a top to bottom examination of NASA, forcing the space agency to come to grips with the true dangers of flying the space shuttle. The committee, which has the greatest congressional oversight of the National Aeronautics and Space Administration, scheduled a hearing for Thursday, but the major NASA inquiry must await the Columbia Accident Investigation Board's final report expected in about a month, committee aides said. Using the board's report as a starting point, the congressional panel will conduct a full-bore investigation that concentrates on the policies, management and safety philosophy of the space agency, according to a committee source who spoke only on condition of anonymity. "We're going to look at the NASA budget, the requests that were made, statements that were made, the final appropriations, and what, if anything, could have been done to prevent this (Columbia accident)," the committee source said. "We are going to be looking generally on the future of the space program." Among the issues is how the agency now contracts out much of the detailed work on the shuttle and whether these contracts affected safety. The committee also wants NASA to explain its plans for returning to Earth the three-man crew on the international space station now that the shuttle fleet is grounded because of Columbia's destruction 3 1/2 weeks ago. One of the major targets of hearings, sources said, will be the contract held by the United Space Alliance, a combination of aerospace companies that does most of the detailed work of maintaining, refurbishing and launching the space shuttle at Florida's Kennedy Space Center. NASA engineers provide oversight in key supervising positions. Another issue, said a committee source, is how diligent NASA has been in following up on safety studies by independent boards. Engineering assessments of the shuttle have been conducted for years by expert committees of the National Academy of Sciences and by other panels. There are dozens of reports in NASA's own archives warning about risks linked to the shuttle's thermal tiles, which are thought to have played a role in the Columbia accident. Web posted. (2003). [NASA Recovery Hinges on Shuttle Probe [Online]. Available WWW: <http://www.space.com/> [2003, February 25].]

◆ A fragment of videotape shot by one of the astronauts on Columbia's flight deck during the early stages of re-entry Feb. 1 has been recovered by NASA. But sources say the heat-damaged tape ends before the onset of problems in the left wing that ultimately led to the orbiter's destruction and the deaths of the ship's crew. As such, the tape provides no insight into the mishap. But sources familiar with the tape say the astronauts showed no signs of any concern as they prepared for return to Earth after a 16-day science mission. The tape has been shown to astronaut family members, the sources say, and will be shown to lawmakers in Washington on Wednesday before its eventual release to the media and public. The digital video tape, presumably shot by astronaut Laurel Clark, begins around 8:35 a.m., some nine minutes before Columbia fell into the discernible atmosphere 400,000 feet above the Pacific Ocean northwest of Hawaii. The tape continues for four minutes past "entry interface" and then abruptly ends around 8:48 a.m., four minutes before the first telemetry was received indicating problems in the shuttle's left wing. Sources say no other tape remained on the heavily damaged cassette. Web posted. (2003). [Cockpit video found; tape ends before problems [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, February 25].]

◆ Space Shuttle Atlantis briefly moved out of the Vehicle Assembly Building on its mobile launch platform Tuesday but was rolled back into the hangar. The giant crawler that carries the shuttle rolled out of the giant hangar then returned to another bay. That bay has cranes that will be able to detach Atlantis from her orange external fuel tank and two solid rocket boosters. In about 10 days, Atlantis will move over to a smaller processing hangar minus the fuel tank and boosters. Web posted. (2003). [Space Shuttle

Atlantis Rolled Out, Then Put Back In Hangar [Online]. Available WWW: <http://news.yahoo.com/> [2003, February 25].]

◆ The object that accompanied Columbia in its orbit on the ship's second day in flight almost certainly came from the orbiter, investigators said Tuesday. The object measured about 1 foot by 1.3 feet, said Brig. Gen. Duane Deal of the Columbia Accident Investigation Board. "It would be an incredible coincidence for something to be floating around in that exact orbit," Deal said. "You could say with a reasonable amount of certainty that it did come from the shuttle." Officials at Wright-Patterson Air Force Base in Ohio are looking at archived tapes, trying to determine the make-up of the object by examining how light reflected off it. The object first appeared after Columbia had made its first maneuver of the flight. The ship had gone into a right-wing-first orientation, then moved back to engines-first. The object was just one piece of a growing web of evidence discussed at the board's Tuesday briefing, when investigators unveiled photos of a dramatically scarred and burned shuttle tile found near Fort Worth. The pictures show unusual damage under the tile and on its surface indicative of extreme heat, but the cause of the damage still is unclear. Investigators haven't ruled out that the object shadowing Columbia in orbit was a tile, but it could have almost any lightweight object that fell away from the ship. Because of Columbia's need for different positions to accommodate Earth-observation experiments, this flight had among the highest number of maneuvers on orbit, Deal said. The payload bay doors were open, so the object could have come from the payload bay, which housed the Spacehab double research module during the flight, and the crew likely wouldn't have seen it, Deal said. There were windows only on the roof of the Spacehab. Radar data consulted after the accident revealed the existence of the object. "They tracked it until there were no more radar tracks of it," Deal said. The loss of radar data on Jan. 20, three days after it first appeared, and its descent were characteristic of an object burning up in the atmosphere. ["Board: Mystery object from shuttle," **Florida Today**, February 26, 2003, p 1A & 3A.]

◆ Jacobs Sverdrup Inc., an Air Force and NASA contractor, confirmed Tuesday it plans to lay off some of its workers at Cape Canaveral Air Force Station. The company would not say how many workers it will lay off. It said the job cuts are the result of "a lack of funding," and is seeking government money to avoid, or at least minimize the layoffs. The pending layoffs have alarmed Transport Workers Union of America Local 525 President Chris Hunt, whose union represents many of the Jacobs Sverdrup workers. Hunt thinks the Feb. 1 shuttle Columbia disaster is a factor in the job cuts. However, the Air Force said it advised the company to reduce its expenses because less money became available under its contract. Hunt said Jacobs Sverdrup initially told him 85 workers would be laid off, but the company has since reduced that number to 49. That would be about 8 percent of the firm's almost 600 workers at the Air Force Station and Kennedy Space Center. The Air Force Station workers affected perform support services related to unmanned rocket launches. ["Contractor at Cape to lay off workers," **Florida Today**, February 26, 2003, p 1A.]

◆ A new office building to be erected at Kennedy Space Center sends a powerful message to those toiling through the aftermath of the Columbia accident. "This is a really good time," KSC director Roy Bridges said. "It's symbolic for our people, the fact we're out here building for the future." Ground was broken for the Operations Support Building 2 on Tuesday. The \$40 million, five-story complex will house about 860 offices as well as training and conference rooms and a mission conference center that can hold 352 people. About three-fourths of the new building will be used by United Space Alliance workers who prepare the shuttle for launch, said Mike Wetmore, director of shuttle processing. The building is scheduled to be finished in March 2005. ["KSC begins work on building," **Florida Today**, February 26, 2003, p 1B.]

FEBRUARY 26: The second flight of Lockheed Martin's Atlas 5 rocket has been postponed to replace the Centaur upper stage after a manufacturing concern was raised, managers announced Wednesday. Launch was scheduled for March 14 from Cape Canaveral to deliver the Greek Hellas Sat communications satellite into Earth orbit. An official new date is pending. A Lockheed Martin spokeswoman said a problem was uncovered with a welding station in the Centaur production factory. After the fault was found, technicians inspected the various Centaurs already built to determine if any had welds that were suspect. Another Centaur currently undergoing final assembly will be shipped to the Cape as a replacement. Web posted.

(2003). Mission Status Center [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, February 26].]

◆ The head of the Columbia Accident Investigation Board told members of Congress that it may take six months to learn all the factors involved in the destruction of the space shuttle, but information on the direct cause will be released as soon as it is discovered. Rep. Sherwood Boehlert, R-New York, chairman of the House Science committee, met with retired Navy Adm. Harold Gehman Jr., head of the investigation panel, on Wednesday and said the board is still uncertain what caused Columbia to break apart over the skies of Texas on February 1. A number of theories are still under consideration. "They are not jumping to any conclusions," said the congressman. Boehlert said Gehman estimated that completing the Columbia investigation will take "two to six months," but that the root cause of the accident may be found earlier. The congressman quoted Gehman as saying, "If we can find out what went wrong that will be released immediately." This would enable NASA to start fixing the problems and allow the other space shuttles to fly sooner, Boehlert said. Web posted. (2003). Shuttle board probe may take six months [Online]. Available WWW: <http://www.cnn.com/> [2003, February 26].]

◆ Astronomers have started a countdown to the launch of two robotic buggies on a mission to find out if there is, or ever was, life on Mars. Charles Elachi, director of the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory, said final preparations were underway with one "exploration rover" arriving at Cape Canaveral this week and the second due in three weeks. He said the rovers, which are the size of an office desk, were set to be launched on May 30 and June 25, piggy-backing on two rockets then parachuting down to Mars in January in an air-bag cushioned landing. Elachi said there was strong interest in the latest launches after recent indications there could be water ice on the red planet. Interest was also keen after the loss in 1999 of two robotic Mars missions -- a lander and an orbiting spacecraft -- at a cost of \$290 million. Missions to Mars can only occur every two years when the planets are in the favorable alignment. Liquid water is seen as key for Earth-type life on a planet and underground water ice could help show how Mars developed. Web posted. (2003). NASA starts countdown to Mars mission [Online]. Available WWW: <http://www.cnn.com/> [2003, February 26].]

◆ Independent investigators probing the Columbia disaster have released pictures of a protective tile from the doomed shuttle with mysterious orange marks, which could support the theory that the craft was damaged in an in-flight collision. "This is not re-entry heat damage," retired admiral Harold Gehman, who heads an independent panel probing the demise of Columbia and its seven crew members, told reporters Tuesday. The protective tile -- its surface seared from exposure to extreme heat -- was found by search teams near the town of Powell, in northeastern Texas. The photographs, made public by the investigative board, showed bright orange deposits in jagged grooves on the surface of the tile, the origin of which Gehman conceded remained mysterious to him. Columbia disintegrated in the sky over eastern Texas on February 1, as it was reentering the atmosphere ahead of its scheduled landing at the Kennedy Space Center in Florida, following a 16-day science mission. Web posted. (2003). Collision theory gains currency in Columbia disaster probe [Online]. Available WWW: <http://www.spacedaily.com/> [2003, February 26].]

◆ Dozens of people at Johnson Space Center and beyond were aware that engineers discussed a potentially catastrophic landing for Columbia in advance of the disaster, new e-mails released Wednesday show. But despite close parallels between the e-mail scenarios and the accident, flight controllers say the discussions were just an exercise prior to the shuttle's fatal landing attempt Feb. 1 and did not indicate any advance knowledge or expectation of a disaster. The most dire e-mails, one of which suggested the left wing could burn up, were sent after NASA had approved a Boeing analysis that predicted that foam that came off the shuttle's external tank may have caused extensive tile damage but would not lead to burn-through. "I had no reason to doubt the thermal analysis that said there was not going to be any burn-through on the vehicle," Jeff Kling, the mechanical systems officer in the flight control room the morning of Feb. 1, said Wednesday. "Because I had confidence in the thermal analysis, I was not at all concerned with the health of the vehicle for entry day." The e-mail chatter wasn't just a discussion among a few engineers, as some officials have characterized "what-if" scenarios proposed after the analysis of external-tank foam that hit the wing during launch. The e-mails went to employees of NASA and contractors in mission operations, space shuttle systems, space and life sciences, flight mechanics and other divisions. Among the discussions were thoughts on what kind of sensor readings ground controllers might get if a breach in the wheel well let

in hot gases during reentry. One description is jarringly similar to what Columbia experienced in its final minutes. "First would be a temperature rise for the tires, brakes, strut actuator, and the uplock actuator return," Kevin McCluney wrote in a Jan. 31 e-mail sent to more than a dozen people. "Tire pressure (and theoretically brake pressures as the fluid temperature increased, though the expansion is small) would rise given enough time, and assuming the tire(s) doesn't get holed. Then the data would start dropping out as the electrical wiring is severed . . . Data loss would include that for tire pressures and temperatures, brake pressures and temperatures Bob Doremus, a flight controller who is the lead for the mechanical systems group, pooled the e-mails after the accident at the request of shuttle program manager Ron Dittmore. He was among those who saw the discussions during the flight. The e-mail discussions interested the engineers who work for him, he said, because they are experts on landing-gear systems. There was no reason to think the gloomy, specific possibilities were anything but "what-if" scenarios, he said, because he had no information to suggest the Boeing analysis of the foam strike was wrong. ["More e-mails cite fears," **Florida Today**, February 27, 2003, p 1A & 3A.]

◆ Studies to determine whether the ill-fated shuttle Columbia was fatally struck by foam on liftoff were based partly on tests looking at small hits the orbiter might absorb rather than the large section of insulation that collided with the space plane. The orange foam that smashed into Columbia on Jan. 16 is thought to be the largest to crash into a shuttle, leading to speculation that the orbiter's heat-shielding tiles were catastrophically damaged less than two minutes into the mission. Some aerospace experts said Wednesday that it is difficult to extrapolate what a large hunk of foam might do to the shuttle's thermal-protection system based on strikes from smaller pieces. NASA officials defended their method of calculating possible tile damage, saying they are "conservative" and realistic. Their basis, in part, was a 1999 study by the Texas-based Southwest Research Institute that was released Wednesday. Once Columbia was aloft, NASA asked shuttle contractor The Boeing Co. to assess the damage that might have occurred. Boeing engineers ran a number of simulations, using a model devised by the Southwest Research Institute of San Antonio in March 1999, according to NASA spokeswoman Kylie Moritz. Southwest is an independent laboratory that has been conducting assorted NASA research for 40 years. ["Small debris used in 1999 tests," **Orlando Sentinel**, February 27, 2003, p A1 & A12.]

FEBRUARY 27: The chairman of the commission probing the space shuttle Columbia disaster told lawmakers yesterday that investigators are closing in on the precise cause of the accident and may issue preliminary findings as soon as the next month or two, several participants in the meetings said. "We think they're close to causation," said Rep. Ralph M. Hall (Tex.), the ranking Democrat on the House Science Committee, following a meeting on Capitol Hill with retired Adm. Harold W. Gehman Jr., chairman of the investigative panel. Gehman declined to speculate on the exact cause of the breach of the shuttle's left wing that triggered the accident, which killed the seven crew members, but indicated that investigators "have narrowed it to the neighborhood," added Rep. Bart Gordon (D-Tenn.). Republican and Democratic lawmakers were also shown a new videotape of the most comprehensive schematics and photographs assembled to date plotting the shuttle's fatal reentry into Earth's atmosphere, showing how it began shedding pieces and finally disintegrated over Texas early Feb. 1, only minutes from landing in Florida. The videotape -- which has not been made public -- incorporates a matrix of data from shuttle sensors and photographs taken from the ground by government agencies and private individuals. The tape documents that the shuttle began to break up much earlier than NASA officials had originally assumed. Web posted. (2003). Shuttle Panel Close to Naming Crash Cause [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, February 27].]

◆ The three astronauts aboard the international space station will be replaced by a two-person crew in the spring as NASA tries to keep the outpost running on limited resources. Scientific experiments are the primary rationale for the station, and NASA Administrator Sean O'Keefe told a congressional committee Thursday that the crew still will be able to conduct research. But some experts did not share that view. "It would curtail them severely," said Rae Silver, a professor at Columbia University who last year chaired a panel of experts commissioned by NASA to evaluate the scientific potential of the station. The new crew -- one American and one Russian -- will fly to the station aboard a Soyuz spacecraft in late April or early May, O'Keefe said. It will replace Americans Kenneth Bowersox and Donald Pettit, along with Russian Nikolai Budarin, who arrived in late November and were scheduled to fly home on shuttle Atlantis in March. The three will come home aboard a Russian Soyuz that is docked on the station for use as an

emergency-escape vehicle. Two astronauts and two cosmonauts are already in training in Star Center, Russia. ["Decision will cut station crew to 2," **Orlando Sentinel**, February 28, 2003, p A12.]

◆ NASA Administrator Sean O'Keefe said Thursday that there are no immediate plans to reduce Kennedy Space Center's work force because of the indefinite hold on shuttle flights after the Columbia tragedy. O'Keefe made his comments at a hearing of the House Science Committee on Thursday in response to a question from Rep. Tom Feeney, R-Oviedo, whose district includes KSC. NASA hopes to resume shuttle flights as soon as safely possible, O'Keefe said, but employees have plenty to do in the interim. This includes work on future shuttle missions and preparations to receive parts for the international space station. They also have a new duty: piecing together Columbia's wreckage. At KSC, O'Keefe said, there is "a lot of busy activity going on, and a lot of folks really attending to it, and spending an awful lot of time above or beyond their normal workday." ["KSC workers can breathe sigh of relief," **Orlando Sentinel**, February 28, 2003, p A12.]

FEBRUARY 28: Air Force and NASA contractor Jacobs Sverdrup Inc. has postponed layoffs it planned to announce today at Cape Canaveral Air Force Station. The company also canceled a two-week furlough of Air Force Station workers it planned for later this year, Jacobs Sverdrup General Manager Joe Hollis said Thursday. Jacobs Sverdrup was able to cancel the furlough – which would have affected more than 450 employees – after government officials came up with extra money for the company, Hollis said. The company also had planned to issue layoff notices today which would have gone into effect in two weeks. But government officials asked the company to delay issuing the notices for two weeks, while they try to get more money to avert or minimize the pending job cuts, Hollis said. ["Air Force contractor delays layoffs," **Florida Today**, February 28, 2003, p 1C & 3C.]

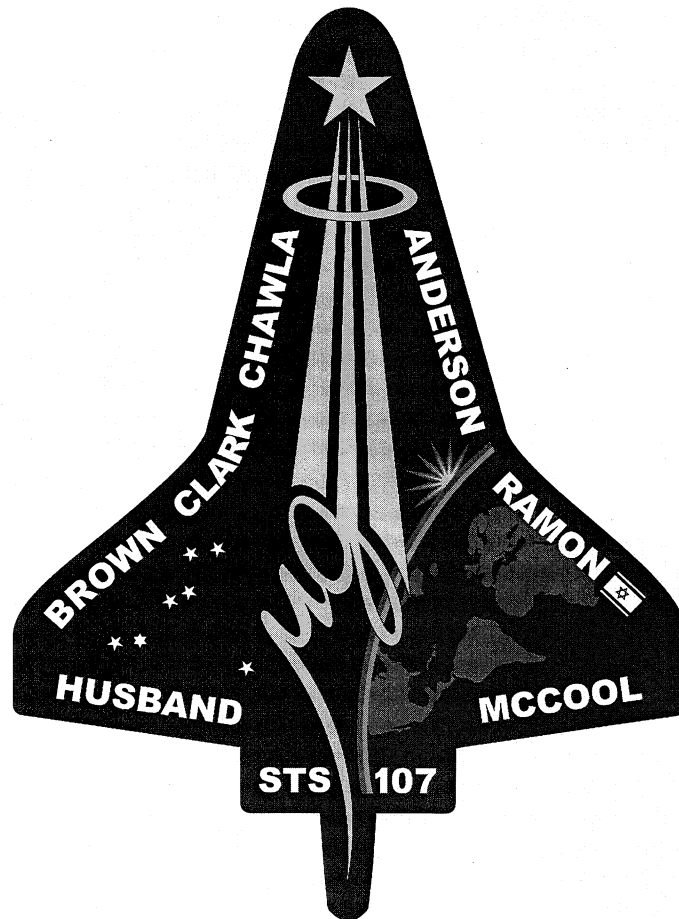
◆ A videotape that shows activities aboard the space shuttle Columbia as it re-entered the atmosphere was released Friday by NASA. The partially scorched and burned tape was recovered near Palestine, Texas, during a search for shuttle debris, the U.S. space agency said earlier this week. The videotape runs about 13 minutes long, but stops short of the first sign of trouble on the spacecraft, which broke up on February 1. Shot from the flight deck, it shows several astronauts and later the view outside the window, where colorful, super-hot gases known as plasma built up around the outside of the shuttle as it plunged into the atmosphere. "It's a bright orange yellow, all over the nose," observed one crew member. "You see sort of a swirl pattern," another said. Scott Altman, the commander of the previous Columbia mission, said Friday that the visual display was ordinary. "All the plasma effects noted on the tape are typical of a normal night re-entry," he said. At the time, the shuttle was in predawn darkness. It soon entered morning daylight over the continental United States. Normal conversations can be heard among other crew members as well, who check gauges, put on their gloves and comment on the gravity forces. Shortly after the left wing developed a variety of problems, the orbiter broke up 39 miles over Texas, killing the crew of seven. A suspected breach in the wing may have allowed the plasma to enter and spark the disaster, shuttle investigators think. The video was shot with a small camera mounted near shuttle pilot Will McCool, who removes it and hands it to mission specialist Laurel Clark for additional taping, NASA said. The video begins when the \$2 billion spacecraft passed over the south central Pacific Ocean at an altitude of about 95 miles and ends when it was over the eastern Pacific, southwest of San Francisco. It includes nine minutes before and four minutes after re-entry, and ends about 11 minutes before Mission Control lost the signal from the doomed orbiter. Shuttle crews usually record their entire return flight to landing, but "we believe the rest of the tape was destroyed during the mishap," Altman said. Web posted. (2003). NASA releases shuttle re-entry video [Online]. Available WWW: <http://www.cnn.com/> [2003, February 28].]

◆ Contrary to published reports, the Columbia Accident Investigation Board did not ask NASA Administrator Sean O'Keefe to remove shuttle program manager Ronald Dittmore from an active role in the agency's ongoing probe of the Columbia disaster, sources say. The New York Times reported today that board Chairman Harold Gehman requested the reassignment of Dittmore and other unnamed senior managers because of concerns about conflicts of interest. Sources close to the investigation told CBS News today that Dittmore, who inspected debris today at the Kennedy Space Center, was not among the names submitted to O'Keefe. Two sources said the list included Linda Ham, a former flight director and the head of NASA's mission management team, and Ralph Roe, a former launch director and manager of the shuttle program's vehicle engineering office at the Johnson Space Center in Houston. It is not yet known if the

board requested any additional reassignments. A source said the request for reassignments was not meant as a reflection on anyone's personal integrity, it was simply in keeping with a desire to ensure the independence of the ongoing investigation. As chairman of the MMT, Ham ultimately accepted the results of a Boeing analysis of the potential damage to Columbia's left wing from the impact of foam debris from the ship's external tank 81 seconds after launch. The analysis concluded Columbia's wing might suffer significant damage during re-entry, but that even so, the vehicle could safely land. Ham presumably played a role in a decision not to request a detailed photo survey of Columbia's underside using powerful Air Force telescopes. Wayne Hale, a senior flight director now serving as launch integration manager at the Kennedy Space Center, made inquiries about the possibility of Air Force help inspecting Columbia, but those initial efforts were terminated by senior management. "The SSP (space shuttle program) did not want any data and in fact there was never a formal MOD (mission operations directorate) request made from the FDOs (flight dynamics officers) or the Flight Director," Steve Stich, a flight director himself, wrote in an email to a colleague. In an interview today to discuss various aspects of hypersonic flight, Hale declined comment on the matter, saying "I probably ought to wait until I tell the board my story. That's coming up." Web posted. (2003). Board didn't seek removal of Dittmore from investigation [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, February 28].]

◆ NASA investigators have narrowed the likely area where debris struck shuttle Columbia during launch to four panels on the leading edge of the ship's left wing. The development is significant because it matches an area around the left wing's leading edge where some engineers theorize superhot gases first pierced the shuttle's protective heat armor during re-entry. A breach there could explain some of the left-wing temperature spikes and sensor failures seen by flight controllers before Columbia's breakup over Texas on Feb. 1. But as has become the norm in this complex investigation, other evidence suggests different scenarios. A briefcase-sized chunk of foam insulation, estimated to weigh about 2.7 pounds, broke free from Columbia's external fuel tank and hit the wing's leading edge 82 seconds after liftoff Jan. 16. Documents obtained by from the Space Shuttle Vehicle Engineering Office at Johnson Space Center indicate the debris struck in the vicinity of panels 6 through 9 on the leading edge. Those U-shaped panels -- made of a reinforced carbon-carbon material designed to withstand temperatures greater than 2,300 degrees -- lie in and outside a slight curve in the leading edge where the wing arches away from the fuselage. The impact location came from a new analysis of data from Columbia's liftoff and a review of earlier studies. ["NASA narrows area for foam hit," **Orlando Sentinel**, March 1, 2003, p A1 & A12.]

◆ Flight engineers might have tried a heroic, Apollo 13-style fix for the shuttle Columbia had it shown obvious signs of trouble before its deadly re-entry, NASA's chief said Friday. "Given the history of this agency, there is positively nothing that would have been spared in our efforts to try and find out what to do to avoid a catastrophe," agency Administrator Sean O'Keefe said during a roundtable discussion with reporters. O'Keefe's contention marked an apparent shift in position for the National Aeronautics and Space Administration. On Feb. 1 -- the day Columbia broke up over Texas -- space shuttle program manager Ron Dittmore told reporters that even if damage to the spacecraft's critical thermal protection armor was extensive, engineers would have been helpless to correct it. "There's nothing we can do about tile damage once we get to orbit," Dittmore said, a sentiment he repeated six times that day. "With all due respect to Ron, he's not speaking for the agency in this regard, OK," O'Keefe said. "I fundamentally, absolutely reject the proposition that there was nothing that could have been done on orbit." ["NASA might have tried heroic rescue, O'Keefe says," **Orlando Sentinel**, March 1, 2003, p A11.]



This is the insignia for STS-107, which is a multi-discipline microgravity and Earth science research mission with a multitude of international scientific investigations conducted continuously during the planned 16 days on orbit. The central element of the patch is the microgravity symbol, μg , flowing into the rays of the astronaut symbol. The mission inclination is portrayed by the 39 degree angle of the astronaut symbol to the Earth's horizon. The sunrise is representative of the numerous experiments that are the dawn of a new era for continued microgravity research on the International Space Station and beyond. The breadth of science conducted on this mission will have widespread benefits to life on Earth and our continued exploration of space illustrated by the Earth and stars. The constellation Columbia (the dove) was chosen to symbolize peace on Earth and the Space Shuttle Columbia. The seven stars also represent the mission crew members and honor the original astronauts who paved the way to make research in space possible. The Israeli flag is adjacent to the name of the payload specialist who is the first person from that country to fly on the Space Shuttle.

MARCH

MARCH 1: NASA will move officials directly involved with the Columbia mission off the investigation into the loss of the shuttle to avoid possible conflicts of interest, according to letters released today by the independent board in charge of the inquiry. In the letters, Admiral Harold W. Gehman Jr., who leads the board, asked NASA administrator, Sean O'Keefe, on Feb. 25 to replace "top level space shuttle program management personnel who were involved in the preparation and operation" of the mission with "other knowledgeable people to manage the response and investigation support." In a letter dated Feb. 28, Mr. O'Keefe replied, "We will assign professionals from outside the shuttle program management structure to lead these efforts." He said it would be done "in the next few days." Web posted. (2003). [NASA Moving Some Officials From Inquiry of Columbia [Online]. Available WWW: <http://www.nytimes.com/> [2003, March 1].]

◆ By Feb. 26, 1986, one month after the Challenger disaster, investigators knew the cause. Video tape and still photographs showed that an O-ring on the right solid rocket booster triggered events that caused the shuttle to blow apart. "I would say that a month into it, early on we knew the problem was with the solid rockets," said Sally Ride, who was the first American woman in space and a member of the Rogers Commission, the group President Reagan appointed to investigate the Challenger disaster. By March 1, 2003, one month after Columbia disintegrated over Texas, investigators have a lot of leads -- including foam insulation falling off the external tank and hitting the orbiter's heat shield tiles and an object floating near the shuttle on its second day of the mission. But there is no "smoking gun." "Since we don't know what happened, we are obliged to do a full-court press on every one of these avenues: safety, flight crew performance, materiel, aerodynamics, thermodynamics, imagery reconstruction, debris reconstruction, because we don't know where the golden nugget is going to be," Adm. Hal Gehman, chair of the Columbia Accident Investigation Board, said. The original charter for the Columbia Accident Investigation Board gives the group 60 days to make their final report. They have said it will probably take longer than that. Howard McCurdy, a space expert and American University professor, said he estimates the investigation could take about nine months. Massachusetts Institute of Technology Prof. Eugene Covert, who also served on the Rogers Commission, said the missing link to the accident will probably be harder to find in Columbia's case. Both boards were asked to find the technical cause of the accident and also broader implications for NASA. ["'Smoking gun' eludes experts one month later," **Florida Today**, March 2, 2003, p 1A & 8A.]

MARCH 2: For four long weeks, the searchers have been slogging through mud and brush in Texas, buoyed by the unflagging support of big-hearted small towns. Investigators have been flying around the country, reading reports until their eyes hurt. And much of the space community has been transformed into an analytical machine, working day and night to find out what happened to destroy shuttle Columbia on Feb. 1. They are tired. Many are working seven days a week. But their sense of mission is unwavering. "We've been working a hundred-plus-hour weeks, but I truly believe we're the lucky ones here," said Rikki Ojeda of Merritt Island, a United Space Alliance manager for Columbia who was sent to Lufkin, Texas, to help lead the debris search. "We're busy. We're out being productive." He got to Texas the day of the accident and was planning to head home Friday. After work in the field, he joined the command center, where he helped ensure the search crews had what they needed before they went out in the morning and when they came back at night. "We've been working seven days a week since we got here," Ojeda said last week. "I had an afternoon off to watch the Daytona 500, but other than that, days range from 14 to 18 hours a day." Like Ojeda, much of his team was dispatched from Kennedy Space Center. There are thousands of searchers in central Texas working to find pieces of the shuttle, and many have been touched by the selfless acts of the small towns into which they've swarmed. In Maypearl, about 35 miles south of Dallas, the whole town mobilized for a three-day search that involved four-wheelers, horses and lots of free pizza. "If we could help bring closure to the NASA people and the families by bringing these pieces back . . . that's what they wanted," said Linda Jackson, a volunteer firefighter who also works for the town. "You don't get that opportunity in Maypearl, Texas, very often." ["Shuttle probe exhausting," **Florida Today**, March 3, 2003, p 1A & 3A.]

◆ The shuttle Columbia investigation will have a much more far-reaching impact on the space program than simply solving the mystery of what triggered the spacecraft's fiery fall to Earth four weeks ago. The catastrophic loss of the \$1 billion machine and its priceless crew of seven has opened the civilian space agency to a level of scrutiny and doubt it has rarely encountered in its 45-year history. In a candid moment at agency headquarters Friday, NASA Administrator Sean O'Keefe told a group of space industry reporters he is aware of just how high the stakes are. "When you go through an intensive fish-tank examination like this, one where it's out there for all the world to see, it's warts and all," O'Keefe said. "I have no doubt in my mind there are going to be lots of things that come out of this that may have absolutely nothing to do with what precipitated the accident at all." There is no question every centimeter of the shuttle program will be combed for improvement by the Columbia Accident Investigation Board. But the independent panel probably won't stop there, O'Keefe predicted. "That is the pattern in any aftermath of a cathartic event like this," O'Keefe said. "There will be plenty of things that are emerging now and will continue to emerge that will motivate a change in the way we look at doing business." Long-studied issues like shuttle crew escape devices, on-orbit repair kits and alternative re-entry plans for the 88-ton orbiters are back on the table along with other basic questions such as: Do the benefits of sending humans into space outweigh the substantial risks? At a congressional hearing Thursday, several lawmakers from both major political parties openly suggested public dollars would be better spent on cheaper, safer and perhaps more-productive unmanned missions. ["Investigation could reshape space agency," **Florida Today**, March 3, 2003, p 3A.]

◆ The destruction of shuttle Columbia hangs over the heads of Brevard County's legislative delegation as it prepares for the 2003 session that begins Tuesday. "From the initial day, the day of the accident, I expressed that we need to quickly find out what happened to the orbiter, but we also needed to be ready as a state to make sure the critical labor force stays together," said Rep. Bob Allen, R-Merritt Island. The shuttles have been grounded indefinitely since Columbia's Feb. 1 re-entry disintegration and death of its seven-member crew. Shuttle operations were suspended at Kennedy Space Center, which employs 15,000 workers. The last suspension occurred after the explosion of shuttle Challenger in 1986. It lasted 2 ½ years. Keeping that critical work force intact also is on the mind of Sen. Bill Posey, R-Rockledge. Posey said he doesn't think the shuttle program can preserve its seasoned work force if it goes through another round of layoffs. But he said the political scuttlebutt is that President Bush won't allow the latest suspension, now in its second month, to last long enough that layoffs become necessary. ["Shielding KSC work force steers agenda," **Florida Today**, March 3, 2003, p 5A.]

MARCH 3: Russia's space chief warned today that time is running out for Washington to finance construction of extra Russian spacecraft needed to run the International Space Station during a break in U.S. shuttle flights. "The problem has to be resolved within a month," Russian Aerospace Agency director Yuri Koptev said during a seminar with Italian government officials and aerospace executives in Moscow. Koptev said Russia is ready to build extra spacecraft, but needs additional funding from U.S. and other partners in the 16-nation space station project. He said if an agreement isn't reached soon, new ships won't be ready in time. "We can build a ship in a minimum of one and a half years. We could maybe squeeze it into 14 months, but anything shorter is impossible," he said. Russian Soyuz capsules and Progress cargo ships remain the only link to the space station following the Columbia shuttle disaster and the suspension of U.S. shuttle flights pending an investigation. But NASA says potential funding is constrained by U.S. legislation barring additional payments to Russia's space agency unless the United States confirms Russia has not transferred missile technology or nuclear, chemical or biological weapons to Iran in the previous year. Koptev acknowledged "political limitations" on the U.S. side but expressed hope that the issue would eventually be resolved and said it was being discussed on the "presidential level." ["Russia warns time running out to build crafts to reach Alpha," **Florida Today**, March 4, 2003, p 2A.]

◆ NASA has agreed to move some shuttle workers off the Columbia investigation and bring in employees who don't work directly on the shuttle, if that's what the external board wants. "They're in the process of transitioning members," said Lt. Col. Woody Woodyard, spokesman for the Columbia Accident Investigation Board. Letters between retired Adm. Hal Gehman and NASA Administrator Sean O'Keefe indicate that is what the board wants. "The Board requests that you reassign the top level Space Shuttle Program management personnel who were involved in the preparation and operation of the flight of STS 107 back to their duties and remove them from directly managing or supporting the investigation," Gehman wrote O'Keefe on Feb. 25. "We believe it is in the best interest of these key people, NASA and the effective

progress of the investigation if they were to be replaced by other knowledgeable people to manage the response and investigation support." At issue were members of NASA's investigative team, which reports to the independent board, who were also part of the decision-making process during Columbia's mission. NASA spokesman Doc Mirelson said that NASA employees who support the shuttle program, such as aerodynamics experts, could potentially help with the investigation. Mirelson said he did not know how many people this could affect or when. ["NASA to shift shuttle workers helping board," **Florida Today**, March 4, 2003, p 2A.]

MARCH 4: Another truckload of debris from shuttle Columbia is expected to arrive at Kennedy Space Center today, adding to the 32,000 pounds of pieces already at the center. About 800 pieces are on the grid at the Reusable Launch Vehicle hangar, NASA spokesman Bruce Buckingham said, but they represent a small fraction of the whole. Last week, a spokeswoman for the Columbia Accident Investigation Board said more than 13,000 pieces had been found. Some are so small they are put in plastic bins before they are placed on the grid. Others are more recognizable and remarkably intact, such as the nose landing gear. Other pieces are stored in another building at KSC, Buckingham said, such as payload bay doors or items carried on the ship. "They've been deemed initially to not be part of the investigation," he said. Nonetheless, they are bar-coded and entered into the database of parts from the shuttle, which disintegrated over Texas upon re-entry Feb. 1. Air searches for debris in Texas have again been hindered by poor weather, NASA spokesman Kelly Humphries said from Lufkin, Texas. "It is socked in," he said Monday. Thousands of ground searchers are still at work in Texas. Over the weekend, volunteers in Marin, Sonoma and Mendocino counties in California combed the beaches 30 miles north and south of Columbia's track to see if anything fell into the Pacific Ocean and washed ashore, Humphries said. No debris west of Littlefield, in the Texas panhandle, has been confirmed. ["More debris to arrive at KSC today," **Florida Today**, March 4, 2003, p 2A.]

◆ Tires and debris recovered from the space shuttle Columbia suggest that the left tires blew out and superheated gases were flowing out of the left wing's wheel well, investigators said Tuesday. The independent board looking into what brought down the doomed orbiter cautioned that the new evidence, while tantalizing, leaves many questions unanswered. "We believe that it's possible that the tires on the left side blew out," said Roger Tetrault, a member of the Columbia Accident Investigation Board. "The blowout of the tires would have been a very catastrophic event." The threads from the two left tires were "basically pulled apart," he told reporters in Houston. In contrast, the tires from the right wing look more like those from a more normal airplane accident, Tetrault said. Whether the blowout took place before or after the orbiter began disintegrating remains unknown. Until contact was lost with the shuttle, the data transmissions indicated the tire pressure was normal, said board chairman retired Navy Adm. Harold Gehman. Web posted. (2003). [Debris suggests shuttle tires blew out [Online]. Available WWW: <http://www.cnn.com/> [2003, March 4].]

◆ Analysts combing through shuttle Columbia's wreckage found molten aluminum and stainless steel inside the front edge of the orbiter's left wing and aluminum residue sprayed on the underside of both wings. "I don't know exactly whether that is coming from the event or whether that's coming from re-entry heating," said Roger Tetrault, a member of the Columbia Accident Investigation Board, the group examining the Feb. 1 shuttle accident. Experts analyzing the debris at Kennedy Space Center found this weekend that a thick soot-like substance on tiles on the wing had a high concentration of aluminum, the same metal that forms the orbiter's support structure. "That deposit has never been seen on any previous flights," Tetrault said. Tetrault said teams are not recovering much of the aluminum structure, so the soot may show what happened to it. They also saw some of the molten metal on the underside of the right wing, but not to the same extent. Behind the front part of the wing, investigators said both melted aluminum and stainless steel were found. The structure that supports the reinforced carbon-carbon is made of stainless steel, which melts at about 2,500 degrees. Tetrault said that melted metal was found on fittings that support the four reinforced carbon-carbon panels closest to the body of the orbiter. More metal was found on the inside of panels farther out on the wing. The front edge of the aluminum wing is flat. Attached to the front of each wing is a series of 22 U-shaped pieces made of reinforced carbon-carbon designed to limit heating of the aluminum structure to 350 degrees. Between each segment is a seal, made of the same material. The seals allow the segments to move side to side and expand slightly under the intense pressure and heat they bear during reentry. A coating is applied to further protect the carbon-carbon surface. The area has been hit

by debris before during a 1992 mission. Investigators said they are looking at one of the seals being damaged during the mission. The board has said they believe that somehow, superhot gas that builds up beneath the shuttle on re-entry found a way inside the left wing. ["Investigators find melted metal on heat shield tiles," **Florida Today**, Wednesday, March 5, 2003, p 3A.]

◆ Apparently fed up with the speculation, NASA Administrator Sean O'Keefe passionately defended the National Aeronautics and Space Administration's network of flight controllers, problem solvers and managers who concluded Columbia had not been seriously damaged by foam that broke off the external tank during launch. "It seems pretty clear here there wasn't anything I've seen or anybody else has hinted at that would suggest malice, or complacency or indifference," O'Keefe told reporters gathered at NASA headquarters Tuesday. The space agency chief held out the possibility that the Columbia Accident Investigation Board will conclude NASA's decision-making process was flawed. "We are wide open for that. We are ready for that finding," he said. But O'Keefe appeared more concerned by what he said is the media's push to place blame for the Columbia disaster before the investigation board finishes its work. "We need to step back just a bit and not jump and reach a judgment about others' judgment until we see its overall context and then make a determination," O'Keefe said in his second appearance before reporters in four days. O'Keefe's comments were echoed by William Readdy, a veteran shuttle astronaut who is now associate administrator for human space flight. Among the first group of astronauts who returned the shuttle fleet to space after the Challenger explosion in 1986, Readdy said NASA does a much better job now of assuring flight safety. ["NASA chief defends agency," **Florida Today**, Wednesday, March 5, 2003, p 3A.]

◆ The families of the Space Shuttle Columbia (STS-107) crew have requested NASA to release the following letter to the media and public. "The families of the Space Shuttle Columbia crew are deeply grateful for the generous outpouring of support and affection we have received from around the world over the past three weeks. "Many people have asked how they can honor the STS-107 crew and assist our families during this difficult time. There are several charitable funds that have been established on our behalf. Information about these funds can be found at: www.columbiashuttlefund.com "Sincerely, The Columbia Crew Families" ["A Letter to America From the Columbia Crew Families," **NASA News Release #03-092**, March 4, 2003.]

MARCH 5: Searchers combing for pieces of space shuttle Columbia over the weekend became sickened by fumes, but they probably weren't exposed to chemicals from the downed spacecraft, officials said Wednesday. Three of the 46 searchers were hospitalized after being affected by fumes during Sunday's search. The team was composed of wilderness firefighters and officials from NASA and the Environmental Protection Agency. Searchers described a hole in the ground that was emitting a chemical smell. "We do not think it's related to the shuttle debris," said EPA spokesman Dave Bary. Web posted. (2003). [Chemical fumes sicken shuttle searchers [Online]. Available WWW: <http://www.cnn.com/> [2003, March 5].]

◆ Investigators are sifting through debris from shuttle Columbia for potentially crucial video, audio and computer evidence that could help explain the ship's Feb. 1 breakup over central Texas. Dozens of cameras, recorders, computers, tapes and rolls of film aboard Columbia could hold data on the shuttle's last minutes. Unlike other debris that is shipped to Kennedy Space Center, items on this list are being sent directly to the manufacturer or to Johnson Space Center in Houston for analysis. "We continue to put a high emphasis on recovering anything that holds data," said retired Navy Adm. Harold W. Gehman Jr., chairman of the panel investigating the Columbia accident. One of the few finds made public so far – a video filmed by the crew members during their ill-fated re-entry – documents 13 minutes from the early stages of the astronauts' return home. Three of the most sought-after items are cameras that were mounted on Columbia's belly where propellant lines from the external fuel tank enter the shuttle. Foam insulation broke free from the tank about 82 seconds into flight and struck Columbia's left wing, possibly damaging the shuttle's protective heat panels and tiles. Other items investigators would love to find include Columbia's two operational recorders. Dubbed the "ops recorders" for short, the devices were the closest thing Columbia had to the so-called black boxes flown aboard commercial aircraft. Recordings of the crew's conversations over the shuttle's intercom system would be stored there along with air-to-ground communications and telemetry data from the orbiter's systems. Investigators are searching for other

recorders as well. A payload recorder usually is operated from the ground by flight controllers and dumps data from the shuttle during the mission. Computers from Columbia's computer and flight-control systems also are high on investigators' wish list. The shuttle contains five general-purpose computers that control the orbiter's basic functions. Each of the 64-pound IBM computers has memory areas for recording data. Columbia also carried a dozen laptop computers used primarily for operations orbit. Some flight-control data are displayed on the laptops, but the computers are stowed for re-entry. Investigators are searching as well for parts of Columbia's high-tech electronic display panels from the shuttle's glass cockpit. The displays show the shuttle's flight instruments, gauges and warning messages. ["Tapes, computers may spit out clues," **Orlando Sentinel**, March 6, 2003, p A1 & A13.]

◆ The board investigating the causes of the shuttle Columbia accident added three members Wednesday, including former astronaut Sally Ride. Ride, the first U.S. woman in space and a member of the 1986 presidential commission that investigated the Challenger explosion, will be joined by space policy expert John Logsdon and Douglas Osheroff, a Nobel Prize-winning physicist. Retired Adm. Harold W. Gehman Jr., who is chairing the accident investigation, asked NASA Administrator Sean O'Keefe to add the three. Also at Gehman's request, astronaut Michael Bloomfield will replace Bryan O'Connor, who had been one of the NASA staff members supporting the board. ["Sally Ride, 2 others join shuttle probe," **Orlando Sentinel**, March 6, 2003, p A13.]

MARCH 6: Shuttle program manager Ronald Dittmore, testifying today before the Columbia Accident Investigation Board, said safety is the agency's "lifeblood" and that his door is always open to any lower-level engineer who might be worried a safety issue is not being properly addressed. Making his first public appearance since a round of high-profile news conferences immediately after the Columbia disaster, Dittmore said the system currently in place ensures critical information and safety concerns make their way up to senior managers and that this culture of safety is firmly in place across the manned space program. "All I can say is we cultivate that culture," Dittmore said. "Anybody can come and walk in my office and say they've got a problem. Anybody can walk into any of our senior (managers') offices, say they have a problem and we will listen to then. I would be very disappointed if I found it to be otherwise." But Harry McDonald, former director of NASA's Ames Research Center and chairman of a 1999 independent review of shuttle systems and maintenance practices, said the system can only work if it's based on the correct assumptions about what constitutes risk and if a system is in place to help managers access technical data. "I have no concern at all that people like Ron Dittmore, presented with the facts, will make the right decision," McDonald said today. "No concern at all on that issue. The concern is presenting him with the facts and many of them are buried deep." Many of the major recommendations made by McDonald's panel - the Space Shuttle Independent Assessment Team - were implemented by NASA. But others were not. McDonald said the agency continues to rely on archaic database technology that makes it difficult to quickly search for relevant test results across the program's history. Case in point is concern about potential damage to the shuttle's protective heat shield tiles from impacts by foam insulation ripping free of the ship's external fuel tank during launch. A large piece of debris fell off Columbia's tank 81 seconds after liftoff Jan. 16 and struck the underside of orbiter's left wing. Columbia was destroyed Feb. 1 when a breach in the left wing, possibly caused by the foam impact, allowed super-heated air to burn its way inside, ultimately triggering the shuttle's aerodynamic breakup 207,000 feet above Texas. All seven crew members were killed. During the flight, engineers carried out an analysis based on earlier tests and extrapolated from that data to conclude that while Columbia's wing might suffer significant damage, there was no safety of flight issue. Web posted. (2003). [Columbia investigators begin public hearings into accident [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 6].]

◆ NASA's space shuttle manager admitted Thursday that the loss of hundreds of experienced California shuttle engineers last year was a major problem, but said the space agency had dealt with it successfully. In the first public hearing of the Columbia Accident Investigation Board, shuttle manager Ron Dittmore was quizzed heavily on work force issues and their relation to flight safety. Air Force Gen. John Barry asked about the transfer of hundreds of contract engineering support jobs to Johnson Space Center and shuttle overhaul jobs to Kennedy Space Center. Of the 500 engineering support positions that were transferred, only 100 California employees elected to move. The rest had to be newly hired. Barry wanted to know if the moves, along with a study of privatization, were "too much all at one time." Dittmore said no. But among the jobs that moved were the Boeing engineers who provided the in-flight analysis that

debris hitting Columbia's wing on liftoff wouldn't be a safety problem at landing. The shuttle was destroyed after superheated air entered its left wing on descent to Earth Feb. 1. The liftoff debris hit is a key suspect. Dittmore said NASA was acutely aware of how many people were being lost in the move. Managers met regularly and knew "by name, by individual, who was coming, who wasn't coming." Many of the new hires in Houston ended up having previous shuttle experience with other contractors, Dittmore said. Those who didn't received extra oversight, he said. "I cannot overstate the fact that it was a difficult task, overall," Dittmore said. Still, he defended the geographic moves. In the long run, it made sense for engineering support, formerly in Huntington Beach, Calif., to be located in Clear Lake along with operations and management, he said. Closing the Palmdale, Calif., shuttle maintenance facility in favor of Kennedy Space Center made sense because California workers routinely got laid off between shuttle rehabilitations, Dittmore said. By having all hands-on shuttle work in Florida, an experienced, long-term work force would be developed. Dittmore said that after the move, each engineering support team in Houston was essentially labeled as having enough experience or not. Those who weren't received extra supervision. He did not say which way the debris analysis team had been labeled. Boeing spokesman Ed Memi said, "Everybody felt comfortable with the experience level of the people on the analysis team. The people directly involved with the analysis were experienced and certified. There may have been some newbies, but they would have been working in a support role." Web posted. (2003). [Shuttle chief admits to staff attrition [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, March 6].]

◆ A law enforcement officer accused of pilfering debris from space shuttle Columbia has been charged with stealing government property. Four people now have been indicted on charges alleging they stole shuttle parts that landed in East Texas after Columbia broke apart Feb. 1. Web posted. (2003). [Space Shuttle Debris Indictments [Online]. Available WWW: <http://www.cbsnews.com/> [2003, March 6 1].]

◆ Seventeen years of successful shuttle flights made NASA managers complacent or overconfident about the aging and complex spacecraft, Columbia investigators were told Thursday. In the first public hearing by the independent investigators, a former top official testified Thursday that NASA decision-makers accepted risks based on past success, an analysis that provoked memories of similar findings by the presidential commission that investigated the 1986 Challenger explosion. "There was a basic flaw in the reasoning of many well-intentioned people," said Henry "Harry" McDonald, the former director of NASA's Ames Research Center in California. With each successful mission, McDonald said NASA leaders convinced themselves the odds of catastrophe decrease when they do not. McDonald, and several members of the Columbia Accident Investigation Board, suggested several times that NASA may be treating the aging shuttles as "operational" vehicles, like passenger jets, rather than the complex research and development vehicles they still are after more than 100 flights. Two other witnesses testifying Thursday, shuttle program manager Ronald Dittmore and Johnson Space Center director Jefferson Howell, disagreed with any suggestion the agency underestimates shuttle risks or does not put the highest possible emphasis on safety. Both testified they were comfortable with how the program, and safety, are managed within NASA. They also said the agency has enough government inspectors in place to oversee shuttle contractors. Safety drives everything shuttle workers and managers do, Dittmore said. ["Successes made NASA complacent, expert says," **Florida Today**, March 7, 2003, p 1A & 7A.]

◆ Some of the foam insulating the shuttle's external tank can absorb water, which could freeze once the tank is loaded with supercold liquid fuels an expert from The Boeing Co. testified Thursday. Keith Chong, who has worked with the North Carolina-made foam used on both the shuttle and his company's Delta 4 rocket, contradicted previous statements made by NASA that the foam is impervious to water and therefore would not have delivered a heavy blow to the orbiter's heat shield during launch. The distinction is important because it raises the possibility that foam falling from the tank could be heavier than NASA and contractor analysts thought when they were studying how much damage might have been done to Columbia's left wing during launch Jan. 16. The Boeing Co.'s analysis on the debris strike focused on "light foam, dismissing the notion that the falling chunk could be ice falling from the same area of the tank or much heavier foam that had become wet and then frozen. ["Boeing expert: Foam could absorb water," **Florida Today**, March 7, 2003, p 7A.]

◆ NASA's administrator urged Congress on Thursday to allow the space agency to change the way it recruits and retains its brightest scientists and engineers. Administrator Sean O'Keefe warned that NASA

faces dangerous shortages because of looming retirements and fewer college graduates with skills it needs. O'Keefe described the situation as "alarming" at a Senate Hearing, and said the agency's specialized employment requirements were destined for crisis unless lawmakers approved changes. O'Keefe said the situation was especially poignant, given questions about NASA's future after the Columbia accident. The agency has been lobbying for these changes for more than a year. It employs about 19,000 people worldwide. ["NASA asks for hiring flexibility," **Florida Today**, March 7, 2003, p 8A.]

◆ NASA is studying five broad changes to space-shuttle hardware and operations that could be in place before the fleet returns to flight. * Redesigning foam insulation on the external fuel tank around the spot where the orbiter is attached to the tank with a pair of struts. * Finding a way to fix the shuttle's thermal-protection system in orbit. * Improving ground-based photo and radar coverage of the shuttle during launch. * Installing cameras aboard the shuttle for additional photo coverage of launch. * Exploring possible changes to the shuttle's trajectory during re-entry to minimize heating on the wing's leading edges and protective thermal tiles. All the potential improvements are issues that have surfaced in the wake of shuttle Columbia's Feb. 1 breakup during re-entry that killed seven astronauts. The move is significant because it could shorten the time needed to return the shuttle fleet's three remaining orbiters to flight. Managers at the National Aeronautics and Space Administration insist any major changes in design or operations must wait until the cause of Columbia's accident is pinpointed and an investigative board has released its findings and recommendations. By anticipating some of those possible changes, however, the shuttle program could be ready to move ahead more quickly once the panel's work is done. ["NASA ponders 5 safety changes," **Orlando Sentinel**, March 7, 2003, p A1 & A14.]

◆ A spacecraft designed to look at some of the oldest processes in the inverse, as well as budding planets, arrived by truck on Thursday at Kennedy Space Center. The Space Infrared Telescope Facility, or SIRTf, is scheduled for launch April 15 at 4:34 a.m. on a Boeing Delta II rocket. It was shipped to Florida from the Lockheed Martin plant in Sunnyvale, Calif. The spacecraft faces further tests in a NASA hangar at Cape Canaveral Air Force Station. The rocket is still being prepared. The second stage is to be lifted onto the rocket on Wednesday at Pad 17B at the Air Force station. ["Infrared telescope arrives at KSC," **Florida Today**, March 7, 2003, p 1B.]

MARCH 7: With the Air Force Honor Guard, his family and many of his fellow astronauts looking on, Michael Anderson, a payload specialist on the space shuttle Columbia, was laid to rest Friday at Arlington National Cemetery. Two other Columbia astronauts, mission specialists Laurel Clark and David Brown, will be buried at Arlington next week. ["Arlington burial honors Anderson of Columbia crew," **Orlando Sentinel**, March 8, 2003, p A13.]

◆ Linda Ham, a top-level space shuttle program manager and the leader of NASA's Mishap Response Team, on Monday will be replaced in her role in the Columbia investigation, agency sources said Friday. Randy Stone, deputy director at Johnson Space Center in Houston, will become a liaison to the independent board probing the Feb. 1 loss of Columbia, the sources said. As the head of the mishap team at JSC, Ham has been the main liaison to the board. But retired Adm. Harold W. Gehman Jr., chairman of the investigation board, asked NASA Administrator Sean O'Keefe to move some of the employees closest to the shuttle program back to their regular jobs, to avoid anyone having to investigate his or her own work. The National Aeronautics and Space Administration will announce Monday which employees will be working with the Gehman board -- and who will be moved away, Glenn Mahone, the agency's associate administrator for public affairs, said Friday. He would not identify the employees. Ham and several others on the mishap team also sat on the Mission Management Team during Columbia's 16-day mission. That group is responsible for dealing with any issues that arise during a shuttle flight -- and, in the case of Columbia, made crucial decisions about whether debris that hit the orbiter during launch had done enough damage to threaten the shuttle on re-entry. Also Friday, the investigation board decided to add another working group to look at NASA's culture, board spokeswoman Laura Brown said. ["Investigators will drop a key shuttle manager," **Orlando Sentinel**, March 8, 2003, p A13.]

MARCH 8: A federal panel is probing why NASA thought it was safe to launch two shuttles, including Columbia, after Atlantis was struck in October by fuel tank insulation -- a hazard that engineers thought needed to be corrected. NASA established a team to solve the problem after a chunk dislodged from

Atlantis during liftoff and struck a booster rocket Oct. 7. Even though engineers developed or were developing safety improvements, NASA launched Endeavour Nov. 23 and Columbia Jan. 16 without making any adjustments to the shuttles' fuel tanks. In coming weeks, the Columbia Accident Investigation Board will try to learn the basis of NASA's rationale for launching despite knowing of hazards posed by flying insulation, a source close to the board said. About 80 seconds after launch, insulation or some other debris appeared to blow off the external fuel tank's bipod -- the area where the orbiter connects to the tank -- and strike Columbia's left wing. Investigators believe a hole in the left wing allowed superheated gases to penetrate the shuttle's skin. After Atlantis' launch, NASA's engineers developed a better way to apply insulation but did not immediately implement the changes because dislodged debris was viewed as causing only minor damage to an orbiter, said Parker Counts, a deputy administrator in the shuttle program. NASA had no plans to re-do insulation on eight completed external fuel tanks. Improvements would be introduced only on future fuel tanks assembled at a New Orleans plant, Counts said. "It was not an issue that was of inordinate concern," Counts said. Flying debris often caused minor damage to shuttles' tiled underbellies. This damage, however, was viewed as a maintenance, not a life-threatening issue, NASA Administrator Sean O'Keefe has said. NASA's view, however, has changed since Columbia disintegrated over Texas, killing seven astronauts. In a Feb. 27 memo, Ron Dittmore, shuttle program manager, wrote that a solution to dislodged insulation needed to be found as part of NASA's preparation to return shuttles to flight. Web posted. (2003). [Panel probes why flight made after Atlantis hit [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, March 8].]

◆ Working through a process of elimination, NASA engineers are focusing on 10 major failure scenarios - and combinations thereof - to explain what went wrong during the shuttle Columbia's catastrophic re-entry Feb. 1. Several of those scenarios, outlined in general in a March 7 report, assume a breach at or near the leading edge area of Columbia's left wing and a resulting plume of super heated air that burned its way into the wing's interior. Heat damage in recovered wreckage and telemetry from the doomed ship indicate the deadly plasma may have worked its way into the left landing gear wheel well and then burned through seals around the left landing gear door. Many NASA investigators believe such a scenario, or a variation of that chain of events, best explain the sensor failures and temperature readings downlinked during Columbia's final minutes as well as burn damage on wreckage recovered to date. But other failure scenarios are possible as well and NASA has assigned teams to work through each one in exhaustive detail to determine which ones best fit the existing data and debris damage patterns, agency sources say. The analysis is being carried out as part of NASA's support of the independent Columbia Accident Investigation Board, which has the final say in determining what happened to Columbia and, more important, why it happened. While the leading edge of the left wing is clearly an area of prime focus, engineers have not yet ruled out a burn through from the bottom of the wing, either in an area of presumably widespread tile damage or because of damaged tiles and seals at or near the landing gear door itself. But nearly all of the scenarios under discussion involve presumed breaches toward the front, inboard section of the wing, from the landing gear door forward. And again, NASA sources and others close to the accident investigation board say a breach in the leading edge area is among the most plausible failure scenarios to emerge so far. Web posted. (2003). [NASA works to eliminate failure scenarios [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 8].]

◆ On shuttle Columbia's maiden voyage, astronauts John Young and Robert Crippen took a moment to savor a view of Earth from America's first reusable spacecraft. Then they trained their eyes on a disturbing sight. Turbulence from the launch had dislodged more than a dozen heat-shield tiles from near the orbiter's tail. A shuttle's thermal protection, which includes thousands of tiles, insulating blankets and carbon plating, prevents the inferno of re-entry from destroying an aluminum vessel that otherwise couldn't stand the heat of a pizza oven. But missing tiles during that first shuttle flight were hardly a surprise. By then, problems with the complex puzzle of ceramic tiles had dogged engineers for almost a decade, playing a major role in delaying by more than two years the first shuttle flight, which was finally launched in April 1981. When it came time for Columbia to come home, though, the problematic system defied concerns. It wasn't perfect -- but it worked. "We certainly saw right off the bat that we had lost a few tiles," said Neil B. Hutchinson, a flight director for Columbia's first mission. "We were not happy that they weren't there but based on what the [NASA support] team was saying we were OK." During the next two decades, the space agency would learn to accept the risks of an average of more than 100 missing or damaged tiles during each mission. And during that period, NASA engineers made little progress in significantly

improving the flawed thermal-protection system beyond its original design or in giving astronauts the ability to fix damage in space. Yet both those initiatives have been given renewed urgency in recent weeks, during the probe of Columbia's disintegration during re-entry Feb. 1. Investigators are looking at whether there was critical damage to heat shielding on the left wing. The area of concern includes high-strength plating called reinforced carbon-carbon along the wing's leading edge. The damage may have been the result of a 500-mph blow from more than 2 pounds of foam insulation that broke off the rocket's external tank 82 seconds after launch. ["Idea of tile repairs in space faded after 1st shuttle flight," **Orlando Sentinel**, March 9, 2003, p A1 & A18.]

◆ The launch of Boeing's Delta 4 rocket was scrubbed Saturday night because of technical problems that could not be solved during the 77-minute launch window. A second attempt is planned for March 9 from 6:43 to 8 p.m. The weather outlook calls for a 60 percent chance of acceptable launch conditions. ["Boeing scrubs Delta 4 launch," **Florida Today**, March 9, 2003, p 1A.]

MARCH 9: Ongoing analysis of the final two seconds of telemetry from the shuttle Columbia during re-entry Feb. 1 shows the doomed ship's fuselage, crew module, right wing and right-side rocket pod were essentially intact 32 seconds after the commander's final transmission and that the orbiter's digital autopilot was still flying the spacecraft. A computer alarm generated in that final two seconds of data suggests one of the pilots' joystick hand controllers may have been briefly engaged, but the autopilot was never deactivated before contact was lost. By that point, however, there was nothing the crew could have done to stop the quickening disaster. The telemetry shows Columbia's left wing and left-side orbital maneuvering system rocket pod were either gone or severely damaged, the ship's hydraulic system was empty, its flash evaporator cooling system was in shut down and multiple computer alarms were being generated because of lost data from the orbiter's left side orbital maneuvering system rocket pod. Guidance and navigation data show the shuttle was in an "uncommanded" orientation, yawing rapidly to one side, presumably toward Earth, in what may have been the start of a banking tumble. The yaw rate - a measure of how fast Columbia's nose was swinging to one side - was at least 20 degrees per second, the maximum value the sensors are designed to measure. The actual yaw rate may have been higher. That same two seconds of "ratty" telemetry shows one of the cockpit's two rotational hand controllers, or joysticks, may have been briefly engaged as early as 9:00:01.7 a.m. That was nearly 30 seconds after Commander Rick Husband's final interrupted transmission to Houston at 8:59:32 a.m. But the timing is uncertain because of the duration of software-driven data sampling rates. The final bit of telemetry, however, shows Columbia digital autopilot was still in control when the flow of data finally ceased and that the hand controller was in its normal "centered" position. As such, it is not known whether the RHC was bumped inadvertently by the commander or pilot or whether one of them intentionally gripped the stick with thoughts of taking over manual control. It is also possible both scenarios are false. Data from this final two-second period was corrupted by transmission errors and as such, it is subject to error or misinterpretation. But it was included as part of revision 14 to NASA's STS-107 Mishap Investigation Master Timeline, a revision that was never released, sources say, because an updated version is in the final stages of preparation. At least some of the data in revision 14 may have been corrected, eliminated or expanded in the latest revision. This status report will be updated as warranted when the new revision is released. In any case, engineers now believe the main body of the spacecraft did not begin breaking up until nearly 20 seconds after the final two-second burst of telemetry. Vehicle breakup was preceded by the separation of at least three major pieces of debris beginning around 9:00:02 a.m., at almost the same instant the final two seconds of telemetry began flowing back to Earth after a 25-second data dropout. The timeline also includes more than a dozen "debris shedding" events recorded by observers on the ground as Columbia crossed above California and the southwestern United States. The first such confirmed instance of debris falling away from the shuttle occurred around 8:53:44 a.m., 18 seconds after the spacecraft passed above the California coast just north of San Francisco. Web posted. (2003). [Telemetry shows autopilot on through last transmission [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 9].]

◆ The Boeing Co. Sunday again delayed the launch of a Delta IV rocket carrying a \$200 million defense communications satellite due to the potential for high winds. Engineers will use the delay to make "minor" repairs following Saturday's attempted launch, according to Boeing officials. Web posted. (2003). [Delta IV rocket launch delayed again [Online]. Available WWW: <http://www.cnn.com/> [2003, March 9].]

MARCH 10: On what would have been her 42nd birthday, Laurel Clark was laid to rest with military honors at Arlington National Cemetery today. She will be buried beside two other Columbia crew mates and just a few feet from where the unidentified remains of Challenger astronauts are interred beneath a granite memorial. Web posted. (2003). [Astronaut's love of life remembered in Arlington funeral [Online]. Available WWW: <http://www.cnn.com/> [2003, March 10].]

◆ Boeing's Delta 4 rocket lifted off from pad 37B at Cape Canaveral Air Station at 7:59 p.m. EST. The launch was the Air Force's first Evolved Expendable Launch Vehicle mission. Web posted. (2003). [Delta 4 rocket successfully begins military service [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 10].]

◆ While investigators try to piece together why Columbia disintegrated during reentry killing its crew, a NASA-backed move is underway to upgrade space shuttle systems and hardware to sustain decades more of flight. Government, industry and university experts are set to hold a Space Shuttle Life Extension Program Summit, to be held March 19-20 at the NASA Michoud Assembly Facility near New Orleans, Louisiana. The high-level summit was far along in its planning prior to the Columbia accident, and takes on added importance in charting the future of the space shuttle program. The first Space Shuttle Service Life Extension Program (SLEP) Summit will focus on how to maintain and upgrade the overall space shuttle system. Taking part in the two-day summit, NASA will join with representatives from other government agencies, industry and academia. Central to discussions is assuring that all critical assets are in place to safely and effectively fly the space shuttle through at least the middle of the next decade. Web posted. (2003). [Summit to Focus on Upgrading Space Shuttle Fleet [Online]. Available WWW: <http://www.space.com/> [2003, March 10].]

◆ A Shuttle landing gear expert said Monday his dire predictions of troubles Columbia might face during re-entry got exactly the attention it deserved from mission controllers in Houston. Robert Daugherty said e-mails he wrote colleagues in the days before Columbia's disastrous re-entry Feb. 1 are being mischaracterized by reporters as ignored warnings. "It looks more extreme to you than it does to me, I guess," Daugherty said about some of the language he used in e-mails to mission controllers and other NASA engineers. Daugherty's e-mails got attention because, when mission control asked him what might happen if Columbia tried to land with its left landing gear damaged, his analysis was very close to events that actually transpired in the final moments of the shuttle's flight on Feb. 1. In a teleconference with reporters Monday, Daugherty said his suggestions of a belly landing, crew bailout or worse because of crippled landing gear were meant to give flight controllers the chance to think over their options and get ready for the worst. The e-mails were part of a what-if debate among engineers that NASA said never reached the flight director or other decision-makers at Johnson Space Center. Daugherty said his analysis got where it was supposed to go and flight controllers had serious talks about options. ["Engineer says his e-mails got appropriate attention," **Florida Today**, March 11, 2003, p 3A.]

◆ Russian space officials are warning that the international space station will have to be mothballed unless the United States or another partner in the huge project comes up with \$100 million to pay for more Russian spacecraft to supply a skeleton crew on the station. Alexei Krasnov, deputy head of international cooperation for the Russian space agency, Rosaviakosmos, said that Russia alone has been called on to keep the football-field-sized station supplied after NASA grounded it three remaining shuttles last month. ["Space station needs cash or it will close, Russia warns," **Florida Today**, March 11, 2003, p A7.]

MARCH 11: The search and recovery mission for debris and human remains from the shuttle Columbia has cost more than \$137 million and counting, according to federal officials. The spending total as of March 6 was \$137,855,547 including personnel, payroll, travel and other costs, the Federal Emergency Management Agency reported. That included \$349,067 for state and local government costs being reimbursed to Louisiana and \$244,512 for Texas, FEMA spokesman James Shebl said Monday. Those two states have been the prime focus of the effort, although there have been searches in other states. Those state and local reimbursements are expected to rise, he said, noting that some local officials are "still filling out the forms" to receive assistance. Expenses eligible for reimbursement include search and recovery costs, emergency medical care, security in the affected area and activation of emergency operations centers, FEMA said. FEMA, a formerly independent agency now a part of the Department of Homeland Security,

was put in charge of the recovery effort following the breakup and crash of Columbia on February 1. Parts of the shuttle were scattered over a wide area of the two states. Starting in mid-February, more than 3,000 workers per day have searched 103,000 acres (41,200 hectares), collecting 22,100 pieces of material. As of March 6 the search was using 32 helicopters and nine fixed-wing aircraft; seven boats and underwater sonar units were searching lakes and reservoirs. Web posted. (2003). [Shuttle recovery cost now \$137 million [Online]. Available WWW: <http://www.cnn.com/> [2003, March 11].]

◆ The Columbia Accident Investigation Board today showed video of Columbia's launching that indicates foam debris falling away from the ship's external fuel tank slammed into the lower leading edge of the orbiter's left wing within a few feet of where it merged with the fuselage. The board also revealed that 20 seconds before the foam fell away from the so-called "bipod ramp" area of the tank just under the shuttle's nose, Columbia rocketed through unusually high wind shear. The steering system in the shuttle's left-side solid fuel booster swiveled the rocket's nozzle slightly to counteract the effects of the shear, putting some additional stress on the left side of the vehicle. This event occurred three seconds or so after Columbia endured "max Q," or maximum dynamic pressure. This number varies from flight to flight, but for Columbia, it was around 741 pounds per square foot. Whether that had anything to do with any subsequent damage to the wing is not yet known, but investigators are looking into the matter. "At 62 seconds on launch, we saw one of the larger transients we've seen on the solid rocket motor," said Maj. Gen. John Barry. "It was well within parameters, but interestingly enough, the two largest ones we've seen on ascent both happen to be Columbia, both happen to be going on 39-degree inclinations (trajectories), both have lightweight tanks. So we're trying to identify if there's any commonality there as an additional stress load on the left-hand side of the orbiter, because it was with the left solid rocket motor that had this input." Investigators also are looking into pre-launch repair work in the bipod area of the external tank where foam insulation can be seen breaking away 81 seconds after launch. The shuttle's nose is attached to the forward part of the tank by a two-strut bipod. Just in front of each strut, where they attach to the tank, is an incline made of shaved foam that serves to reduce stress and minimize turbulence as air flows over the area during ascent. Because of schedule changes prompted by the grounding of the shuttle fleet last year due to engine propellant line cracks, Columbia's tank was removed from the boosters that originally were stacked for the mission. Those boosters were used for a different flight. Columbia's tank subsequently was attached to a different set of boosters. During this process, engineers wrote up a "problem report" on damage seen near the left bipod ramp area, but the matter was closed out after a visual inspection. The nature of the damage, and what role, if any, it might have played in the subsequent separation of foam from that area is not yet known. Regardless of what factor or combination of factors led to the initial damage in Columbia's left wing, investigators increasingly believe a breach at or near the leading edge of the wing, near where it joined the fuselage, led to Columbia's destruction. A jet of super heated plasma appears to have burned its way into the interior of the wing and ultimately into the left landing gear wheel well. Web posted. (2003). [Board studies wing edge, wind shear, foam repair [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 11].]

◆ NASA engineer who warned that "getting information was being treated like the plague" defended the space agency Monday, saying his e-mails warning of "catastrophic" results for the space shuttle Columbia were handled appropriately. "The perception that my e-mails weren't taken seriously, frankly, I don't know where that came from," said Robert Daugherty, a senior research engineer at NASA's Langley Research Center. "I thought my e-mails were absolutely taken seriously." Daugherty and several NASA engineers took part in an e-mail exchange that pondered the possibility of Columbia's loss as late as the day before the craft broke up February 1, but those e-mails were not shared with top agency officials. The engineers involved in the exchange were not responsible for assessing possible damage to the orbiter caused by pieces of foam that broke away from the shuttle's external fuel tank 81 seconds after launch. That analysis was completed by two teams of engineers who work for shuttle contractor Boeing. The Boeing studies, which did rise to the highest levels of the shuttle program, suggested that the damage to the heat-shielding tiles might require repairs but was not extensive enough to cause the catastrophic loss of the vehicle and crew. In his first public remarks since the accident, Daugherty backed NASA's position, saying his e-mails were not warnings but rather examples of employees engaging in cautionary analyses, something the space agency encourages. But in a January 29 e-mail to a colleague, Daugherty, an 18-year NASA veteran who is an expert on the orbiter's landing gear, expressed reservations about the tile-damage assessments performed by the Boeing teams in Huntington Beach, California. He wrote, "... They think

things are 'survivable,' but marginal.' "The amount of damage was in some respects unknown. That combined with talking these scenarios [through] with colleagues ..., there was some uneasiness there," he said Monday. "But I certainly believed everything was going to be perfectly fine." When Columbia disintegrated over Texas, killing the seven-member crew, he said, he instantly thought of the e-mails warning of the risks. "Certainly, that is the first thing that ran through my mind," he said. "I was certainly hoping something like that wasn't the case." Daugherty sought permission from NASA's independent investigation board to speak to reporters because he felt some of his e-mail comments had been misconstrued. His comment classifying getting information as "being treated like the plague" was related to simulations being run at the Ames Research Center in California and not to the space agency as a whole, he said. Web posted. (2003). [Engineer who raised red flag defends NASA [Online]. Available WWW: <http://www.cnn.com/> [2003, March 11].]

◆ Negotiations for a new, three-year labor agreement are under way between workers at Kennedy Space Center's Visitor Complex and Delaware North Parks Services of Spaceport, which has a contract with NASA to manage Brevard County's top paid tourist draw. A sizable majority of the Visitor Complex workers, members of the International Association of Machinists and Aerospace Workers District 166/Local 773, turned down one contract offer Friday. Another vote could come sometime within the next two weeks. A union official said a strike is possible, although that is a scenario neither side wants. The employees – both full-time and part-time – work in fields such as guided tours, group and individual ticket sales, retail sales, food service and bus loading. ["Visitor center union rejects pact," **Florida Today**, March 12, 2003, p 1C & 2C.]

◆ The process of detaching shuttle Atlantis from its external fuel tank was under way Tuesday in the Vehicle Assembly Building at KSC. The orbiter is being separated from the tank and solid rocket boosters. By the end of the week, Atlantis should be rolled over to an orbiter processing facility, where maintenance and storage will be easier. It was scheduled to launch this month on a mission to the International Space Station, but the shuttle fleet is grounded pending the outcome of the Columbia investigation. ["KSC begins separating Atlantis from fuel tank," **Florida Today**, March 12, 2003, p 1B.]

◆ A pair of Mars robots have arrived at Kennedy Space Center for their summer launches. A second rover bound for Mars this summer arrived in a truck late Tuesday afternoon after making the cross-country trip from NASA's Jet Propulsion in Pasadena, Calif. The first arrived at the Cape in February. For now, this rover is known as Mars Exploration Rover-1. NASA isn't sure which will ride the first Delta 2 rocket, slated for a May 30 launch from Cape Canaveral Air Force Station. That will be determined later. The second launch will occur no earlier than June 25. The twin rovers are expected to touch down on the surface of Mars in January 2004. NASA's Associate Administrator for Space Science Ed Weiler will announce the rovers' final destinations in April. ["Robots' next stop: Mars," **Florida Today**, March 12, 2003, p 1B.]

◆ 90 minutes after the loss of shuttle Columbia, high-ranking NASA officials already were zeroing in on a possible cause of the Feb. 1 disaster: A devastating burn-through of the fragile thermal armor that protects the ship's left wing. Just as quickly, President Bush, the Joint Chiefs of Staff and Homeland Security Director Tom Ridge were told that the \$2 billion orbiter had been destroyed and its seven astronauts -- including the first Israeli to fly in space -- were presumed dead. A terrorist attack, however, had been ruled out. U.S. Air Force search and rescue squadrons were deployed. But the grim reality already was sinking in. One NASA manager asked agency engineers to calculate "debris location predictions especially for the crew compartment," a newly released NASA document says. Another remarked that "the first priority was crew recovery and their families." Columbia and its five-man, two-woman crew were gone. And the minutes that document the first meeting of NASA's STS-107 Mission Response Team show that the focus quickly turned to a monumental search for shuttle debris that rained down on an area then thought to stretch from Dallas to Tyler, Texas, and perhaps as far east as the panhandle of Florida. Released this week under the Freedom of Information Act, the meeting minutes shed new light on the immediate reaction of senior shuttle program managers and other NASA officials in the wake of the Columbia disaster. A stunned nation was watching video clips on network television of Columbia breaking apart in the skies over east Texas. NASA shuttle program managers, meanwhile, already were preparing to tell the

nation that there was no evidence of sabotage or a terrorist attack -- something clearly on the minds of many in the post-Sept. 11 world, and on a mission whose crew included Israeli Air Force Col. Ilan Ramon. But at the same time, the minutes show that NASA managers already were calling into question the presumption that launch debris slamming into an area near the shuttle's left wing posed no flight safety risk to the ship and its astronauts. A suitcase-sized piece of foam insulation from Columbia's external tank broke loose and struck the orbiter somewhere near the leading edge of the shuttle's left wing or its left landing-gear door about 82 seconds after liftoff Jan. 16. ["Focus immediately turned to left wing," **Florida Today**, March 12, 2003, p 1A.]

◆ A pre-planned steering adjustment by a booster rocket to counteract unusually high wind shear could have weakened the left wing of Columbia and contributed to the loss of the ship and its crew, investigators said Tuesday. A variety of other factors -- such as the age of NASA's oldest orbiter, external tank repairs and the potential for undetected corrosion beneath the thermal armor that protects shuttle wings -- also could have played a role in the disaster, the officials said. Six weeks after Columbia disintegrated over Texas on Feb. 1, the Columbia Accident Investigation Board still is working to determine the root cause of the accident, which killed seven astronauts. But investigators said when a final report eventually is made, the disaster likely will be traced not to a single cause but to a complicated chain of events. "If you agree with the theory that complex systems fail in complex ways, it isn't a matter of a bracket breaking," retired Navy Adm. Harold Gehman Jr. told reporters at a Houston news conference. "It's a matter of a whole series of unfortunate events." Among various scenarios being contemplated by the board, the leading theories still revolve around damage to the leading edge of the shuttle's left wing. Launch video and still photographs show three pieces of foam insulation, all clumped together, breaking free from the shuttle's 15-story external tank about 82 seconds into flight. The debris slammed into the lower part of the left wing's leading edge. It was immediately pulverized, and its remnants then slipped beneath the wing. Investigators, however, do not think the debris alone could have caused enough damage to account for the accident. Rather, other factors likely are at play, board members said. Among possible contributing causes: The age of shuttle Columbia, which was launched on its first flight in April 1981. ["Wind shear may have made wing vulnerable," **Florida Today**, March 12, 2003, p 2A.]

MARCH 12: Bowing to outside pressure, NASA has reorganized a team supporting the Columbia accident board, staffing it with officials who were not involved directly with the shuttle's ill-fated flight. The idea is to make sure the support team does not include NASA officials whose decisions and actions might come under investigation during the probe into the Feb. 1 loss of Columbia and its seven astronauts. The agency also is forming plans to respond rapidly to any recommendations from the board. Both initiatives are outlined in a March 6 letter from NASA Administrator Sean O'Keefe to retired Navy Adm. Harold Gehman Jr., chairman of the Columbia Accident Investigation Board. "We will divide our teams into three, each of which will match up with your Board's subdivisions," O'Keefe wrote to Gehman. "Each team will be led by senior agency officials who were not involved in the Space Shuttle Program Office during the Flight Readiness Review Process, nor during the Columbia STS-107 mission." The independence of the board, which was appointed by NASA immediately after the accident, and the make-up of the agency team supporting the probe have been at issue since shortly after the disaster. U.S. Rep. Bart Gordon, D-Tenn., a member of the House Science Committee, has criticized NASA and the Bush administration for failure to create a presidential commission such as the one that investigated the 1986 Challenger explosion. Gordon and other members of Congress were concerned a NASA-appointed board would lack the independence to pursue a full investigation, and would raise questions about the credibility of any of the panel's findings. The board has been moving quickly to distance itself from NASA during the past two weeks, particularly by asking the agency to reassign support team members who were directly involved with the Columbia mission. Linda Ham, space shuttle launch integration manager at Johnson Space Center, and Ralph Roe, manager of NASA's Shuttle Program Vehicle Engineering Office, were replaced on the support team. Ham, a former flight director, was chairman of NASA's Mission Management Team during the Columbia mission. As such, she was responsible for overseeing all aspects of the flight, including the handling of an analysis of external tank foam debris that struck the leading edge of Columbia's left wing 82 seconds into the mission. The analysis concluded the debris hit would not pose a flight safety risk to Columbia and its crew, but investigators now think the strike might have contributed to the loss of the shuttle. Roe, a former NASA launch director at Kennedy Space Center, was responsible for overseeing all major engineering issues with the spacecraft during the mission. Ham and Roe returned to

their normal duties as NASA moved to reorganize its support team to mirror the three working groups that have been created by the board. NASA also established a so-called "Return To Flight" team, one which is headed by Dr. Michael Greenfield, the agency's associate administrator for Technical Programs. ["NASA reorganizes probe support team," **Florida Today**, March 13, 2003, p 9A.]

MARCH 13: Experts looking into the Columbia accident hope that several ground tests may offer clues as to why the space plane broke up during reentry Feb. 1 as it sped through Earth's atmosphere. Two key tests involve insulating foam used on the shuttle system's large external fuel tank, and trying to identify an unknown object that may have floated away from the space plane on day two of Columbia's 16-day orbital mission. Video of Columbia's liftoff shows something flaking off the external tank -- three distinct pieces - perhaps insulating foam, ice, a combination of the two, or even ablator material used underneath the foam. All the debris appears to fly underneath the wing, striking the lower half of Columbia's left wing and impacting panels of reinforced carbon-carbon designed to take the high heating of reentry. In early April, a major NASA-sponsored test is slated to shoot external tank foam at test specimens of space plane wing materials. Initial foam impact experiments have already yielded a surprising result. A preliminary finding suggests that a striking blow from high-speed foam may harm aluminum structure in the wing, but the thermal protection covering might not show visible damage. Still to be recovered by ground teams, according to a source here, is photographic gear that should have recorded the jettisoning of the external tank from Columbia as the space plane continued onward into orbit. That camera equipment is on the underside of the space plane. If the gear survived the fall to Earth, imagery that was taken might reveal more about what came off the large external tank and from where. The fuel tank itself is destroyed as it tumbles through the air and crashes into a remote ocean area. "We are narrowing down the part of the geography of the orbiter where the assault seems to have taken place," said Columbia Accident Investigation Board (CAIB) chairman, retired Admiral Hal Gehman. Web posted. (2003). [Early Tests Show Foam Debris Impact Harmful to Shuttle Frame [Online]. Available WWW: <http://www.space.com/> [2003, March 13].]

◆ NASA engineers sought satellite images of the damage sustained by the space shuttle Columbia's wing during liftoff on January 16, but were turned down by the shuttle program manager. The request came three days after liftoff and had it been granted the satellite images would "absolutely" have helped to determine any damage to the wing's protective heat tiles, a senior NASA official told the New York Times. NASA officials at first discounted the frozen foam insulation as a cause leading to the disaster, but are now looking into whether the front of the wing, which faces extremely high temperatures on reentry, might have been damaged, causing a rupture in the vessel's protective outer layer that led to its burning up on re-entry. The unidentified NASA official told the Times that in a group meeting Lambert Austin, an engineer at Johnson Space Center in Houston, Texas, had asked shuttle manager Ron Dittmore to obtain satellite images of Columbia. Dittmore turned down the request saying the images might not have been sharp enough to help determine the damage. Web posted. (2003). [Engineers sought satellite images of damage to Columbia wing: report [Online]. Available WWW: <http://www.spacedaily.com/> [2003, March 13].]

◆ Shuttle astronaut David Brown became the 19th astronaut laid to rest at Arlington National Cemetery, one of the seven killed in the Feb. 1 breakup of the shuttle Columbia. The spaceflight was Brown's first. He became an astronaut in 1996. The burial, with full military honors, began with a "missing man" formation flyover. Web posted. (2003). [Seventh Columbia astronaut laid to rest [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, March 13].]

◆ Experts have told NASA for years that covering the wings of a space shuttle while it sits on the launch pad could prevent a problem that investigators now think may have contributed to the destruction of Columbia. But NASA ignored the recommendation, one expert said, even though the idea had been endorsed by top materials researchers inside and outside the space agency. Their suggestion was simple: drape the equivalent of a painter's drop cloth over the shuttle's wings to protect them from corrosive sea air, preventing tiny pinholes from forming on the edges of the wings. Those pinholes -- about as wide as three human hairs -- began to appear on the leading edges of shuttle wings in 1992, first in Columbia, the other shuttles. Pinholes develop after about 10 flights. The oldest shuttle, Columbia, broke apart at the end of its 28th flight, and it had far more pinholes than any other shuttle, according to NASA technical reports. The Columbia accident Investigation Board is looking at the pinholes as a possible contributing cause of

the Feb. 1 tragedy, board member Maj. Gen. John Barry said Tuesday. Web posted. (2003). [Shuttle's long-ignored pinholes eyed as factor [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, March 13].]

◆ Columbia accident investigators are focusing more attention on the protective leading edge of the spaceship's left wing and the possibility it could have been weakened by wear before the flight. Most public attention has swirled around possible damage to the tiles that form the heat shield on much of the wing. But the leading edge, and its highly heat-resistant carbon-carbon protective panels, has recently emerged as an intriguing player. Ongoing tests in a NASA wind tunnel show the forces pulling the shuttle's nose to the left were the result of a major distortion of the left wing, such as the loss of four or more of the 22 panels that make up the leading edge. Tiny pinholes can form in the material that protects the leading edge. Those pinholes can lead to small cavities hidden beneath the surface of the leading edge. Members of the Columbia Accident Investigation Board are closely examining whether current inspections of the panels are sensitive enough to detect damage hidden beneath the surface. The leading edge is one of the parts of the shuttle that heats up the most when the spacecraft re-enters the Earth's atmosphere. Columbia broke up Feb. 1 while re-entering, killing its crew of seven. To protect it, engineers needed something more resilient than the tile that protects much of the shuttle. They chose reinforced carbon-carbon. This mixture of carbon fibers and carbon filler can heat to more than 2,800 degrees without melting. Just behind the panels are the wing spars. They are made of aluminum, which melts at 600 degrees. A failure of the panels could be catastrophic. A 1999 NASA assessment called the material "outstanding." Experts say it's strong, but not impervious to forceful blows. The carbon-carbon material also can burn fiercely if exposed to oxygen during the heat of re-entry. To prevent that, a coating is baked on to it. But that coating, silicon carbide, isn't perfect. After numerous re-entries, tiny pin holes can form in the coating. Enough oxygen flows through the pinholes to melt away bits of the carbon-carbon. Tiny cavities are formed. The cavities themselves are probably no danger, says Robert Rapp a retired Ohio state University researcher who studies high-temperature materials and collaborated with NASA scientists on pinhole research. But if something heavy hit a portion of the panels speckled with pinholes, "that could be a different story," Rapp says. It "could cause a fracture in the coating. If you lost a small amount of coating, you'd be in serious trouble." Beside the pinholes, more significant "dings" have been recorded in the leading edge six different times during the last 12 years, according to the board. Some of those dings came from collisions with micro-meteoroids, tiny rocks in space. Anything in the same orbit around the Earth as Columbia would be traveling 17,500 mph. One study in 2000 said that space rocks and other objects in orbit pose a "significant threat" to the shuttle and singled out carbon-carbon panels as "especially vulnerable." Board chairman Hal Gehman has said that a pinhole alone would be "highly unlikely" to lead to the loss of a panel. But he also said that debris striking panels that have pin holes and dings could "do some damage." ["Board focuses on wing wear," **Florida Today**, March 14, 2003, p 1A & 3A.]

◆ New evidence suggests shuttle Columbia's left landing-gear door remained closed and intact until just before the ship's breakup, bolstering theories that a breach in the orbiter's protective heat armor first occurred near the left wing's leading edge. Salvage teams have recovered a second piece of the orbiter's belly that includes a corner of the left landing gear's wheel well. The debris shows destructive hot gases were flowing out of the wheel well and not into it as they would have if the wheel-well door were the origin of the breach. A similar piece of debris found days earlier showed the same outward flow. "In my opinion, it is a low probability that we are looking at a strike on the [left landing gear] door or a door issue or a [thermal tile] acreage issue around it," a source close to the investigation said. "It is much more likely that we have a problem or a breach that occurred up in the RCC [reinforced carbon-carbon panel] area or the carrier panels immediately adjacent to it." Sources close to the board investigating the Columbia accident told the Orlando Sentinel that the inquiry is focusing more closely than ever on the system of 22 RCC panels that make up the leading edge and the underlying carrier panels that run alongside. The RCC panels are made of tough composite material designed to protect the orbiter from temperatures up to 3,000 degrees during reentry. In recent days, investigators have detected tiny pinholes and small voids caused by oxidation in panels from other orbiters. The significance of the defects isn't known. ["Just-found debris suggests flaws in wing edge," **Orlando Sentinel**, March 14, 2003, p A1 & A10.]

MARCH 14: NASA is making plans to return the space shuttle to orbit as early as this fall and has instructed engineers to be prepared to make any "corrective actions" recommended by the board now

investigating the Columbia tragedy. William F. Readdy, NASA's associate administrator for space flight, issued a memo this week instructing agency officials to organize a team to plan for quickly making changes in the space shuttle – or its operations – so that the craft would be quickly ready to fly. "The team will prepare for a safe return to flight as soon as practicable," the March 12 memo said. "As the goal, the SSP (Space Shuttle Program) shall plan for corrective actions and reviews which support a launch opportunity as early as the fall of 2003." Readdy said that NASA will be guided by the recommendations of the Columbia Accident Investigation Board, which is studying the factors involved in the February 1 destruction of Columbia in which the seven crew members perished. Web posted. (2003). [NASA: Shuttle could fly again by fall. [Online]. Available WWW: <http://www.CNN.com/> [2003, March 14].]

◆ William Readdy, a top spaceflight official at NASA headquarters, said Friday that he rebuffed an offer to use American spy satellites to photograph damage to the space shuttle Columbia's underside because he and others were confident the orbiter was in no danger. Readdy, the agency's associate administrator for spaceflight, said he was approached by a NASA employee who relayed the offer to help -- but only if the agency requested it on an "emergency" basis. After he demurred, Readdy said, the employee -- whom he would not identify -- returned to tell him that the photos might still be obtained if the satellites were not otherwise engaged. At that point, Readdy said, he accepted the offer. But he added that he has no evidence the photographs were taken. "We got nothing after the fact," he said. The Washington Post reported Friday that Readdy himself had asked the National Imagery and Mapping Agency to take the photos. In a meeting with reporters Friday, Readdy refused to identify the agency, citing national-security concerns, but said he did not reach out. Managers at the National Aeronautics and Space Administration had known that as many as three chunks of foam from the shuttle's external fuel tank had slammed into the leading edge of Columbia's left wing and the thermal tiles protecting its belly during liftoff Jan. 16. Investigators now think superhot gas penetrated the leading edge during the shuttle's re-entry, melting the wing and causing the shuttle to explode over Texas. But at the time he was approached in January -- before Columbia's Feb. 1 re-entry but after NASA managers had accepted a Boeing Co. analysis that tile damage was not dangerous -- Readdy said he was comfortable with the situation. Even now, he said, it's doubtful that the photos would have changed the debate. "I can tell you that I'm familiar with the capability; so are other program officials," Readdy said, citing shuttle program manager Ron Dittmore and Columbia mission manager Linda Ham in Houston. There were discussions among engineers and managers there about obtaining satellite imagery, but none was taken. Readdy and NASA Administrator Sean O'Keefe said Readdy's decision, along with others, will be reviewed both within the agency and by the independent board probing the causes of the Columbia accident. "This falls into the category of a judgment," O'Keefe said. Readdy, who outlined the exchange over the satellite images in his statement to the investigation board, said Friday that given the information he and others had at the time, there was nothing to justify asking for the satellites to be pulled off their regular assignments. ["NASA saw no need for shuttle pictures," Orlando Sentinel, March 15, 2003, p A11.]

MARCH 15: Amateur-video footage of shuttle Columbia's early descent over land Feb. 1 shows a continuing shedding of debris, with pieces flaring up as bright blips in the shuttle's plasma trail. The video documentation is described with new details in the latest timeline of the orbiter's final minutes, which was released Friday by NASA. The timeline includes the locations of observers on the ground armed with video cameras. At least 19 people caught the streak in the sky and have turned over their footage to the National Aeronautics and Space Administration for analysis, agency spokesman Kyle Herring said. Herring said two things made the wealth of footage possible: It's easy to see a re-entry in darkness -- Columbia crossed the California coast shortly before 6 a.m. PST -- because the shuttle appears as a bright light in the sky. And the orbiter's landing track carried it over some heavily populated areas. "I hate to use the word 'lucky,' but the way this happened made it very easy for amateur videographers to capture Columbia's re-entry," Herring said. The first observer started filming the shuttle while it was still out over the Pacific Ocean. At least 11 others focused in on the ship through central New Mexico, where it moved over unpopulated desert. The footage picked up again in north-central Texas. Herring said the agency is using the video to help pinpoint the time of debris sightings and possible locations of material that made it to the ground. He said experts used the backdrop of stars in the footage to determine the location of debris incidents. In addition, they are using wind and other weather data from Feb. 1 to narrow the potential "debris footprints" on the ground and aid searchers. "Anything that came off early on is something we're obviously very interested in finding," said Herring, adding that early debris might help determine what triggered the

breakup. One area of particular interest is the region around Caliente, Nev., where an item marked as "Debris #6" on the timeline is thought to have fallen. The object was tracked to the ground by Federal Aviation Administration radar. Meanwhile, Herring said heavy snowfall has halted the search for debris in Utah, where there were three reported sightings near St. George. He said the search may resume again in April. All told, the timeline counts 16 pieces of debris coming off the orbiter -- one more than previously documented. It also notes for the first time that Columbia was experiencing unusual disruptions in communication. The temporary blackouts lasted briefly -- just seconds -- and it's unclear whether they are connected to the shuttle's rising temperatures and aerodynamic drag on the left side. "We don't know what it means," Herring said. "It's just not something that we had seen on any other flight, so they're looking into it." Web posted. (2003). [Amateur footage assists NASA [Online]. Available WWW: <http://www.OrlandoSentinel.com/> [2003, March 15].]

◆ Despite the loss of Columbia and the grounding of the shuttle fleet for an investigation, NASA is working to prevent any layoffs at Kennedy Space Center, U.S. Rep. Tom Feeney said Saturday. One day after meeting with KSC officials to tour the hangar where shuttle debris is being cataloged and reassembled, the freshman congressman told 150 area residents -- some of them space-center employees -- there is plenty of work for the foreseeable future. Shuttle-investigation work, planned orbiter refurbishing and upgrades, probes to Mars and various rocket launches will keep space-center employees busy for months. "I was assured by Sean O'Keefe there are no plans for work slow downs and layoffs," said Feeney, R-Oviedo, a member of the House Science Committee, whose district includes the space center. ["Feeney: Layoffs at KSC unlikely," **Orlando Sentinel**, March 16, 2003, p B1 & B3.]

◆ A massive search for Columbia debris is yielding new clues that are shoring up a leading theory on the cause of the disaster, a source close to the investigation said Saturday. Searchers have recovered internal parts of the shuttle's left main landing gear door that are shedding light on the way in which hot gasses likely breached Columbia's thermal protection system and doomed the orbiter. The new evidence suggests hot gas entered a breach in thermal panels that protect the leading edge of the shuttle's left wing, shooting through the wing's interior before burning through the landing-gear compartment's closed door, ultimately spewing out before the wing itself began breaking up. "That would be one way to explain it," said the source, speaking on condition of anonymity. "Are there other ways to explain it? I'm sure there are other scenarios. But that is one way you could explain it." Columbia disintegrated in the skies over East Texas on Feb. 1, killing all seven astronauts onboard. Investigators quickly turned their attention to debris that broke free from the shuttle's external tank about 81 seconds into the flight. Early analysis of launch video indicated the debris -- thought to be foam insulation perhaps laced with ice -- struck the left wing of the orbiter near its leading edge or the landing gear compartment on that side of the ship. However, a four-second video clip released by investigators Tuesday shows the debris -- now thought to be three separate pieces of foam that formed a cluster -- struck the lower part of the leading edge of the wing. The leading edge of the wing is covered by 22 reinforced carbon-carbon panels that are designed to protect that structure from temperatures which reach about 3,000 degrees Fahrenheit during re-entry. The video shows the debris slamming into an area near so-called RCC panels 6, 7 and 8, potentially weakening those parts. Heat-damaged pieces of the shuttle's left main landing gear door, meanwhile, are adding to the body of evidence. Recently recovered and shipped to Kennedy Space Center, an internal "uplock pin" appears to have been subjected to extreme heat and sprayed with molten metal. An associated titanium flange, meanwhile, "appears to have been eaten away by some kind of high blast of heat," the source said. "And because the melting temperature of titanium is somewhere around 3,000 degrees, that had to be a pretty hot event." The uplock pin and the titanium flange are associated with the mechanical linkage used to open and close the wheel well doors. ["Evidence mounts showing how gas breached shuttle," **Florida Today**, March 16, 2002, p 6A.]

MARCH 16: Columbia investigators early this week will get their most detailed briefing yet on the final minutes of the shuttle's break-up. During public hearings here today and Tuesday, a NASA official will unveil a six-minute video compilation that visually documents Columbia as it streaked over the southwestern United States. Experts on aerodynamics and thermodynamics also will discuss the forces the shuttle was subjected to during the minutes leading up to the disintegration of the ship. The testimony is expected to shed new light on the amount of progress investigators are making in trying to determine the root cause of the disaster, which killed seven astronauts. "You will get a post-graduate-level education on

aerodynamics and thermodynamics," said retired Navy Adm. Harold Gehman Jr., chairman of the Columbia Accident Investigation Board. "And you will be able to tell at the end of that exactly how far we've gone, how deep we've gone, but also, how far we have to go." Columbia and its five-man, two-woman crew were lost 16 minutes before the scheduled end of a 16-day space science flight that was launched from Kennedy Space Center on Jan. 16. Investigators to date have been focusing on the possibility that hot gases encountered during atmospheric re-entry might have breached the leading edge of Columbia's left wing, triggering the disaster. Today, NASA Flight Director Paul Hill will discuss agency efforts to reconstruct the final minutes of Columbia's flight from telemetry data, video and recovered debris. A resulting master timeline of events shows at least 16 major pieces of Columbia fell away from the ship as it soared across the southwestern U.S. before breaking up over Texas. The so-called "debris shedding" events are documented in the new video compilation, which was pieced together by NASA and accident investigators from camcorder images taken by 19 observers on the ground. Those videos pick up the shuttle over the Pacific Ocean as it approached the coast of California and cover most of its flight toward the skies over East Texas. The only gaps in coverage come over sparsely populated areas of eastern New Mexico and northwestern Texas. Experts are using the video, along with radar and weather data, to plot the course of falling debris so searchers can attempt to pinpoint the location of wreckage on the ground. More than 43,000 pounds of debris has been recovered to date, primarily in a corridor that stretches from an area south of Dallas through East Texas and into Louisiana. ["Board will hear details of shuttle's last minutes," **Florida Today**, March 17, 2003, p 1A & 5A.]

MARCH 17: The space shuttle Columbia shed debris all the way from California to Texas during its final minutes of flight before breaking up in a fatal accident last month, a NASA official said Monday. Experts said that if a smoking gun, a definitive clue to why Columbia disintegrated upon reentry to Earth's atmosphere, exists in the debris, it will likely come from the stream of parts that flew off before the shuttle reached Texas. To date, NASA has found nothing west of Texas. "From California, pretty much all the way to Texas, you see a relatively steady stream of objects coming off the orbiter," said Paul Hill, a shuttle and space station flight director. The experts spoke at a public hearing in Houston held by the independent Columbia Accident Investigation Board, charged with finding the cause of the Feb. 1 accident that killed seven astronauts and destroyed NASA's oldest space shuttle. Hill unveiled a composite video of Columbia that covered its flight from California to its final moments over Texas assembled from some 15-20 amateur and military videos culled from some 3,000 videos, still photographs and other reports that reached NASA in the days immediately after the crash. The orbiter first appears as a point of light that gradually grows into the shape of a comet, with a trail of plasma, or super-hot gasses, following it. Pieces are seen coming off the orbiter, the quickly disappearing as they cooled. They appear only as bright points of light. Some are preceded by bright flashes that could be the burning of gasses or fluids escaping the shuttle. Hill said NASA hopes to use the video composite, which gives scientists a firm timeline of when pieces broke away, to plot trajectories and estimate where the pieces landed. Still a mystery to NASA is how Columbia managed to fly across the entire western United States, losing pieces every few seconds, and still managed to perform so well that neither ground controllers nor pilots were apparently aware of any trouble until the final seconds. Web posted. (2003). [Shuttle Columbia's 'Smoking Gun' Said West of Texas [Online]. Available WWW: <http://www.reuters.com/> [2003, March 17].]

MARCH 18: Preliminary consideration of various possibilities has not yet pointed to one likely cause for the breakup of the space shuttle Columbia, NASA engineers told the accident investigation board today. During its third public hearing, the board heard from engineers who are reconstructing the aerodynamics and thermodynamics of the shuttle's re-entry and trying to pinpoint what damage might have occurred and when it would have happened. "You've asked the \$64,000 question," Steven Labbe, chief of the Applied Aeroscience and Computational Fluid Dynamics Branch at Johnson Space Center, told the board when asked what caused the shuttle to break apart over Texas on Feb. 1, killing all seven astronauts. The board suspects the left wing's heat-shielding tiles were breached, possibly by insulating foam or other material falling from the external fuel tank, when Columbia launched on Jan. 16. The breach could have let hot atmospheric gases penetrate the left wing during re-entry. Initial wind tunnel tests on various possible types of damage - including holes in the wing's leading edge, missing reinforced carbon carbon panels on the vehicle's body and a gouge in the main landing gear door - have so far not duplicated the shuttle's catastrophic failure, Labbe said. "We're going to be looking at multiple panels missing, where our future work will focus on. We'll do a survey of the wing leading edge and look at other scenarios," he said. "These

are very preliminary results. It's premature to draw too many conclusions from these results. We're just getting started on this assessment." On Monday, the board heard from shuttle officials and an expert on spacecraft re-entry, who all said a crucial clue to solving the accident could be in a piece of debris yet to be discovered in the western United States. Web posted. (2003). [Wind tunnel tests have yet to duplicate Columbia breakup, expert says [Online]. Available WWW: <http://www.Floridatoday.com/> [2003, March 18].]

◆ A growing body of evidence is shoring up a theory on what caused the loss of shuttle Columbia while helping engineers rule out other accident scenarios, investigators said Tuesday. For their final report, investigators think they will be able to piece together the most likely chain of events that led to the disintegration of the shuttle Feb. 1, killing seven astronauts. "My confidence is still pretty high that we're going to be able to ascertain the root cause of this with some amount of certainty. . . not absolute certainty," said retired Navy Adm. Harold Gehman Jr., chairman of the Columbia Accident Investigation Board. Board member Dr. James Hallock said, "We're going to be looking at what's the preponderance of the evidence." Six weeks after Columbia and its crew were destroyed, investigators still are focusing on debris that broke free from the shuttle's external tank 81 seconds into the launch and slammed into the left side of the spaceship. Launch video and still photography show three pieces of foam insulation forming a cluster and then striking the lower part of the left wing's leading edge. That might have left Columbia's wing vulnerable to superhot gases penetrating the wing when the shuttle re-entered Earth's atmosphere. Investigators no longer think the debris struck or breached the shuttle's left main landing gear door, a scenario under study since shortly after the accident. In fact, investigators now think heat might have pierced a panel that connects thermal tiles on the shuttle's belly with reinforced carbon panels that protect the leading edge of the wing. Such a breach would have enabled superheated gas to shoot through the wing like a blowtorch, melting skeletal aluminum within it. Investigators think hot gas then broke into the left main landing gear compartment before spewing out of its closed door. Hallock said investigators now think the connecting "carrier panel" might have fallen off the shuttle after it reached orbit. Air Force researchers have determined that a "mystery object" that drifted away from the shuttle on the second day of its flight was about the size of such a panel, he said. Hallock said the object reentered Earth's atmosphere on the fifth day of Columbia's flight, a profile that matches what would be expected for a piece of debris the size and shape of the panel. The foam-debris hit, coupled with launch vibrations, could have loosened the carrier panel to the point where it dropped off the shuttle during a firing of its steering thrusters. "The thing to remember is . . . that the first 8 1/2 minutes of going to orbit is a wild ride," Hallock said. "You have to keep an open mind there." Mounting evidence, meanwhile, has enabled the board to eliminate some scenarios as potential factors in the chain of events that led to Columbia's destruction. The fact that Columbia's wings were "rougher" than those on NASA's other shuttles now is being discounted. A rough wing surface can trigger higher than normal heating during the early parts of re-entry, but investigators now think that wasn't the case during Columbia's ill-fated plunge back through the atmosphere. Additionally, investigators have determined there was little NASA could have done during Columbia's flight -- or in the future -- to minimize heat and stress on the shuttle's wings during re-entry. Current re-entry trajectories put the wings in the most benign environment possible, investigators said. Board members, meanwhile, also have been studying data beamed back to Earth from shuttle instruments to determine whether a meteorite or space debris struck Columbia. ["Panel confident of finding cause," **Florida Today**, March 19, 2003, p 2A.]

MARCH 19: A data processing error by the U.S. Air Force prevented early flagging of a mystery object falling off Columbia in orbit -- an object that may be tied to why the space plane disintegrated en route to Earth. During Columbia's second day in Earth orbit, Air Force Space Command ground radar observed a large piece of structure floating free of the space plane. It remained in orbit for a little over two days before nose-diving into Earth's atmosphere. No one in the Department of Defense or NASA knew about the discovery of the fairly large object until days after the loss of Columbia. If NASA had known that the piece was cast off early in the 16-day mission, a campaign to better characterize the object would begun, including use of ground and space-based assets of military and intelligence agencies. The Columbia Accident Investigation Board is attempting to identify the mystery object. Web posted. (2003). [Columbia's Destruction May Be Tied to Mystery Object [Online]. Available WWW: <http://www.space.com/> [2003, March 19].]

◆ The Columbia Accident Investigation Board will soon recommend that NASA establish a formal procedure to request the use of spy satellites to check orbiting space shuttles for damage, its chairman said Tuesday. Space agency personnel discussed making such a request before Columbia's return to Earth on Feb. 1, but ultimately decided the imagery was unnecessary. "One of the earliest recommendations we think is coming up for board consideration is the issue of guidance to NASA to get their act together," said retired Adm. Harold Gehman, head of the panel. The board remains focused on how seriously the shuttle was damaged when a chunk of debris, believed to be insulating foam from the fuel tank, struck the underside of the left wing moments after Columbia's Jan. 16 liftoff. During Columbia's 16-day mission, NASA mission managers concluded that the impact did not pose a safety hazard, though lower-level engineers continued to debate the issue until the eve of Columbia's descent. In some of their correspondence, engineers also questioned why managers did not seek the Pentagon's help in photographing the wing with spy satellites or ground-based telescopes. Gehman blamed NASA for failing to seek security clearances for its personnel to gain access to the classified materials, but also cited the Pentagon for failing to adequately brief NASA on its capabilities. One reason NASA was reluctant to seek the imagery was the 1998 mission of the shuttle Discovery. A panel enclosing the drag chute fell away as the shuttle lifted off, and images the military took were not of sufficient clarity to be useful, according to shuttle program manager Ron Dittmore. That mission ended safely. "That was then," said Gehman. "We think the improvements in photography have come a long way." Meanwhile, investigators have not strayed from their belief that Columbia's disintegration was triggered by a breach of the leading edge of the left wing. Web posted. (2003). [Board to advise on spy satellite use [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, March 19].]

◆ Shuttle commanders could add an unusual maneuver to their flight plans in the future to give ground controllers a look at the orbiters' thermal tile system and other surfaces. The Columbia Accident Investigation Board is expected to recommend that NASA figure out how to inspect the shuttles for damage in orbit. Anticipating that outcome, shuttle commander Brent Jett has been flying simulated approaches to the International Space Station and having the shuttle perform a 360-degree loop before docking with the orbiting outpost. Digital cameras on the bottom of the station will photograph the shuttles' tiles, wing edges and other surfaces, sending those pictures back to controllers in Houston for examination. The maneuver is performed about 600 feet below the station as the shuttle moves along in tandem in a slightly lower orbit, Jett said Wednesday. "There really is no risk of hitting the station," said Jett, who has flown about 20 to 25 of the maneuvers recently using high-resolution simulators at NASA training facilities here. The problem is, the maneuver uses about 100 to 150 pounds of propellant that could be needed for other purposes later in the flight. NASA managers and planners will have to decide whether the checkout maneuver is worth the fuel use. Jett is the commander of STS-115, which was scheduled to fly to the space station later this year. Until NASA's three remaining shuttles are cleared for return to flight, it isn't clear when his crew will complete its mission. The International Space Station is equipped with digital cameras that have powerful lenses that could take extremely detailed pictures of the shuttle as it slowly turns beneath the outpost. Web posted. (2003). [Station camera option considered [Online]. Available WWW: <http://www.floridatoday.com/> [2003, March 19].]

◆ Columbia accident investigators found a key flight data recorder Wednesday, a device that could shed new light on what was happening to the spacecraft before it disintegrated over east Texas on Feb. 1. Searchers found the Orbital Experiment Support System near Hemphill, Texas, in the general region where most of the Columbia debris has been found. About the size of a bread box, the instrument records on magnetic tape data such as temperatures, pressures, vibrations, acceleration, electrical currents and strains on the vehicle. The recorder was recovered intact and taken to Johnson Space Center, where it must be cleaned up before determining how to get to the data without damaging it. The recorder starts up about 10 minutes before the shuttle reaches the first traces of the upper atmosphere. Investigators believe it would have continued to run until the vehicle broke up. "It's a pretty promising find," said Air Force Lt. Col. Tyrone Woodyard, a spokesman for the Columbia Accident Investigation Board. "We're hoping it can provide us some indications of what was going on . . . But we have to be guarded." To date, investigators have been forced to rely on telemetry data beamed back from the shuttle, video and photographs in attempt to piece together what destroyed the Columbia. That information has helped NASA build a timeline of events as the orbiter crossed the southwestern United States on way to a planned landing at Kennedy Space

Center. Web posted. (2003). [Columbia's flight data recorder found [Online]. Available WWW: <http://www.floridatoday.com/> [2003, March 19].]

MARCH 20: Debris recovery teams found a largely intact data recorder from shuttle Columbia on Wednesday, giving accident investigators a potentially major break in reconstructing the doomed ship's final moments. The so-called Orbiter Experiment Recorder, found seven miles west of Hemphill, Texas, is being transported to Johnson Space Center for analysis. The recorder stores flight data including temperature, aerodynamic pressure and vibration readings from a variety of sensors that were located throughout the Columbia. Initial indications are the recorder suffered some heat damage but was in relatively good condition, officials said. Investigators are cautiously optimistic they can recover data. If so, the device's 9,400 feet of magnetic tape could provide a wealth of information on what was happening to Columbia in the minutes before its breakup over central Texas on Feb. 1. "We have no way of knowing whether data can be recovered," said Laura Brown, a spokeswoman for the Columbia Accident Investigation Board. "They suspect there may be heat damage, but they are coming up with a plan to be as careful as possible." The recovery came the same day as 200 government, industry and academic officials associated with the shuttle program met in New Orleans to begin mapping out a long-range plan for extending the life of the orbiter. Web posted. (2003). [Searchers find tape of shuttle's final moments [Online]. Available WWW: <http://www.OrlandoSentinel.com/> [2003, March 20].]

◆ Before the shuttle mission preceding Columbia's flight, NASA flagged as a major concern the loss of foam in the same area on fuel tanks where investigators now believe debris broke away and smashed against Columbia's left wing. The space agency concluded that damage from such breakaway foam did not threaten shuttle safety and determined the fuel tank attached to Endeavour was "safe to fly with no new concerns and no added risk," according to newly released documents from the National Aeronautics and Space Administration. The documents revealed for the first time some of NASA's reasons for deciding months ago that such risks were insufficient to delay shuttle launches, even as agency officials already were looking into what they perceived as a frustrating, recurring problem. The findings were included in more than 1,000 pages of internal reports NASA released late Thursday about the most recent shuttle missions. Investigators believe insulating foam that struck Columbia's left wing on liftoff peeled away from the same region of the external fuel tank, called its bipod ramp. That may have damaged delicate protective tiles on the wing and allowed superheated air to fatally penetrate the spacecraft during its fiery re-entry on February 1. The bipod is a V-shaped structure connecting Columbia near its nose landing gear to the orange-colored external fuel tank. Metal attachments on the tank are covered with ramp-shaped insulating foam that protrudes noticeably from the tank's surface. Tank specialists at NASA identified the foam problem on October 31, 2002, as their only "special topic" of concern prior to the liftoff of Endeavour on November 23, the shuttle flight immediately preceding Columbia's. They cited troubling reports on three earlier missions of foam breaking away from the tank's bipod ramp. But they defended NASA's work, saying the foam was applied with proven craftsmanship by "experienced practitioners" with 20 years of such work. They also noted that the process of applying foam to that part of the tank had not changed since 1993. Web posted. (2003). [NASA flagged foam as 'special topic' before Columbia [Online]. Available WWW: <http://www.cnn.com/> [2003, March 21].]

MARCH 21: NASA on Friday created a new group to help with the investigation of the shuttle Columbia tragedy, dissolving an earlier team that had attracted criticism for including people who had directly overseen the ship's mission. The NASA Accident Investigation Team will replace the Mishap Response Team that was formed within hours of the disaster that killed seven astronauts Feb. 1. The initial group was led by Linda Ham, a top shuttle manager who helped make key decisions during Columbia's 16 days in orbit. The new team will continue to support the outside group that is running the investigation – the Columbia Accident Investigation Board. The board's chairman, retired Navy Adm. Harold Gehman Jr., had asked the National Aeronautics and Space Administration for the reorganization several weeks ago to avoid having some agency officials essentially review their own work. A spokesman said Friday that the board is content with the changes, which put the deputy director of Johnson Space Center, Randy Stone, in charge of NASA's role in the investigation. The new group is organized to mirror the Accident Investigation Board's own structure. Both teams are divided into three subdivisions: materials, operations and engineering. The NASA subdivisions will be led by Stone, who will oversee operations; Frank Benz, director of engineering at JSC who will manage the engineering section; and Jim Kennedy, deputy director

of Kennedy Space Center, who will oversee activities related to materials. ["New team created to help with shuttle probe," **Orlando Sentinel**, March 22, 2003, p A22.]

◆ Aluminum, as commonplace as a soda can in everyday life, has become something of a mystery metal for investigators trying to figure out what caused the destruction of the space shuttle Columbia. The predominant component in the shuttle's structure, this lightweight solid metal can change under certain circumstances into a fast-burning, explosive fuel of a sort used in armor-piercing munitions, bombs and rocket boosters. That realization has led the Columbia Accident Investigation Board to delve into the possibility that, as trouble mounted during Columbia's hot, violent reentry, parts of its very frame might have ignited or even exploded. If so, the burning aluminum may resolve a seeming contradiction that has troubled investigators: Physical evidence indicates that destructive heat raced through the shuttle's left wing, but engineering calculations indicate that scenario could not have unfolded as fast as it evidently did. The explanation, said an official close to the investigation, may be that the aluminum alloy in the frame could have served as a kind of energy multiplier, accelerating the process that doomed the vehicle and crew. The condition of the wreckage indicates that a plume of hot gas eventually vented through the seals around the left landing gear door, possibly emerging as a jet that created excess lift under the left wing. Searchers found a titanium part from the left wheel well that was melted, indicating that temperatures at that location had reached at least 3,000 degrees. Since the engineering calculations suggest that there wasn't enough time for all of this to happen without some other factor, the investigation official said, the board has ordered the aluminum test researchers to make sure the investigating board is not steered off the track by erroneous assumptions. ["Possible Role of Aluminum in Shuttle Disaster Probed," **Washington Post**, March 22, 2003, p A02.]

MARCH 22: NASA may be forced to revisit how it evaluates launch pad weather after losing two shuttles launched in icy January conditions. If investigators determine ice was part of the debris that hit Columbia and somehow contributed to the loss of the shuttle and seven astronauts, then it wouldn't be the first time weather played a role in a shuttle tragedy. Extreme cold -- and managers' acceptance of it -- got part of the blame in the 1986 loss of shuttle Challenger. Before that, NASA had followed a very simple weather rule: Launch only if the temperature is between 31 and 99 degrees. By the 1988 return to flight, NASA had imposed new standards to minimize the effects of cold and ice. The minimum launch temperature was 33 degrees, according to NASA weather officer John Madura. But temperature limits also were determined by charts that incorporated wind speed. Wind can ease the bad effects of cool temperatures and ice. Thus, the rule that lasted through the late 1980s allowed for temperatures of 37 degrees if winds were blowing 4 knots or more and 47 degrees if the winds were calmer. Those rules were deemed too conservative, however, based on advances in meteorological technology and in NASA's understanding of the impact of conditions at the pad. More changes were on their way: By January 1993, they were changed again to give launch controllers more flexibility and to more accurately measure the potential for safe launches, he said. A curve was developed that was more specific about the wind. For example, at 4 knots, the temperature could be 42 instead of 47. Rather than taking temperatures at ground level, where it was often colder, NASA used readings from 60 feet -- "up where the vehicle is," Madura said. No later than the fall of 1994, NASA enacted today's system, which considers relative humidity. With no wind and 90 percent humidity for example, launch is allowed at more than 44 degrees. With less than 64 percent humidity, the air temperature would have to be higher than 48. The Columbia Accident Investigation Board has said that, among other issues, it will be reviewing decisions made about the launch weather rules as well as any waivers and changes in those rules over the years. ["NASA's weather rules may need work," **Florida Today**, March 23, 2003, p 9A.]

◆ Institutional breakdowns inside NASA, including misjudgments and overconfidence by senior shuttle managers, thwarted efforts to accurately assess damage to shuttle Columbia before the ship's fatal flight home. E-mails and documents released under the Freedom of Information Act portray a shuttle program too comfortable with past successes and its ability to measure risk. The mind-set extended to the upper levels of the National Aeronautics and Space Administration and the agency's shuttle contractors. Within hours of Columbia's Jan. 16 launch, NASA engineers already were aware of the damage that may have caused the ship's Feb. 1 breakup during re-entry. Chunks of foam insulation had broken off the shuttle's external fuel tank during liftoff and smashed into the orbiter near the leading edge of its left wing. For the 16 days Columbia was in orbit, NASA managers failed to heed calls from some engineers for more data or

take steps to avoid a potential disaster during re-entry. Requests for critical information were denied because they didn't go through proper channels. Studies drawing conclusions well beyond NASA's past experience were accepted with little debate. Shuttle managers relied on flawed assumptions to breeze through key decisions. And concerns from lower-level engineers never trickled up. NASA's institutional issues have become a central focus of the board investigating Columbia's accident. The board's findings could fundamentally reshape NASA management practices that govern shuttle missions. Agency Administrator Sean O'Keefe has pledged to make whatever changes might be necessary. "It may have been a hardware failure," O'Keefe said recently. "It may have been a systems failure of some kind. "It may have been an error in judgment." The morning after Columbia's Jan. 16 launch, members of the Intercenter Photo Working Group -- engineers that analyze launch images -- were worried. Following an initial look at video images, stunned film reviewers at Kennedy Space Center calculated a chunk of foam insulation had hit Columbia's left wing about 81 seconds after liftoff. Engineers estimated the piece to be about 20 inches across at its broadest point. Other film-review teams at Johnson Space Center in Houston and Marshall Space Flight Center in Huntsville, Ala., reached similar conclusions later that day. Some analysts labeled it the worst foam impact ever seen in 113 shuttle launches. The debris appeared to come from a foam ramp in the tank's so-called bipod area, where a pair of struts mate the orbiter to the tank. Engineers' thoughts immediately shifted to shuttle Atlantis' liftoff three months earlier on Oct. 7. Then, a piece of foam from the same spot had broken loose and hit one of the orbiter's solid rocket boosters. Film reviewers quickly alerted shuttle managers about Columbia's foam hit. Further analysis of the images indicated the ship might have been struck by up to four pieces. There were problems, however, with long-range tracking cameras that had the best view of the impact. Only one of four high-speed 35-mm cameras in position to capture the event produced clear images. One was out of focus. Two others had their view obscured by clouds or failed to track the shuttle. Two video cameras had similar results. One got clear pictures while the other's were fuzzy. Analyses to determine the debris' trajectory and possible tile damage began the same day. On Monday, Jan. 20, a meeting was held to formally organize a damage assessment team. Assessment teams routinely are formed when potential problems crop up during missions. This team included 37 engineers and technical managers from NASA and contractors Boeing, United Space Alliance, Lockheed Martin and Science Applications International Corp. Their job: Determine whether Columbia's protective heat armor had been seriously hurt. The day after liftoff, members of the Intercenter Photo Working Group had made the same request of Wayne Hale, a veteran flight director named the shuttle's launch integration manager at KSC in December. He agreed it could be done after learning that tracking cameras had produced poor images. Hale contacted the NASA support office at Cape Canaveral Air Force Station to get the photo process rolling. The request was forwarded to the military's Cheyenne Mountain facility in Colorado, a command center where collection of satellite data is coordinated. But the message hadn't gone through the proper NASA channels. JSC engineer Lambert Austin called Hale on Jan. 21 to ask about the photos and visited with an Air Force liaison to discuss the request. The next day, the issue reached the desk of Linda Ham, JSC's shuttle program integration manager. Ham killed the photo request on Jan. 22. Exactly why remains unclear. Hale and the damage assessment team found out about the decision later that day. With delays in launch photo information and no prospect of pictures in orbit, the assessment team did the best it could to pinpoint where the foam had hit Columbia's left wing. Meetings on Tuesday, Jan. 21, and Wednesday, Jan. 22, yielded a preliminary analysis estimating the foam had struck somewhere in an area stretching from just behind the left wing's leading edge to the rear of the door covering the left landing gear's wheel well. The analysis by systems integration engineers said the "large uncertainty in trajectory computation does not allow a good prediction of the impact area." After the study predicting where the foam might have hit, engineers used a computer program called Crater to assess possible damage to the shuttle's heat tiles. More than 20,000 of the fragile tiles protect the orbiter from temperatures up to 2,300 degrees during re-entry. The Crater analysis found that the foam could have penetrated all the way through the tiles to the wing's aluminum frame in one area. Nevertheless, engineers concluded that bottom layers of the tiles would survive and that would be enough to protect Columbia during re-entry. The report never considered what would happen if the debris damaged a tile or thermal seal next to the left wing's landing gear door. The analysis also looked at possible damage to the tough reinforced carbon-carbon [RCC] panels that line the leading edge of the wing and encounter temperatures of up to 3,000 degrees. Using data from a 1982 lab test in which ice projectiles were fired at the panels, engineers concluded some of the outer coating could be lost but the panels would remain intact. By Saturday, Jan. 25 -- one week before Columbia's scheduled return -- the analysis of missing tiles on the landing gear door had been finished. Like the other scenarios, it was considered no threat to mission safety. McCormack passed along the final

results to the Mission Management Team on Monday, Jan. 27. His summary the following day in the Jan. 28 MER report concluded there was no safety of flight concern. The issue officially was considered closed. Columbia's crew had been briefed about the foam strike by e-mail and voice communications while in space and told the hit wasn't a safety issue. It appears the astronauts knew nothing, however, about the flurry of satellite photography requests, damage assessments, ground simulations and urgent e-mails. Many of the people who supported the mission on the ground dream of a second chance. Most expect -- and support -- changes to open up communications and improve crucial decision-making so the errors made during Columbia's flight never will be repeated. ["NASA managers missed chances to take closer look for tile damage," **Orlando Sentinel**, March 23, 2003, p A1 & A16-A17.]

MARCH 24: Even as the fatal break-up of shuttle Columbia is being investigated, NASA said on Monday it is exploring ways to keep the remaining three space shuttle flying until 2022. The space agency's long-term plans call for the shuttle fleet to be active at least until a "next-generation launch technology" -- which is in the earliest stages -- makes its first flight some 12 years from now. In one scenario, shuttles would continue to work to extend the life of the International Space Station until 2022 and beyond, said Michael Kostelnik, who head the space station and shuttle programs at NASA. Depending on the findings of the Gehman Board, which is probing the Columbia accident, Kostelnik said the shuttle fleet is likely to look about the same as it does now when it resumes its flight schedule. Kostelnik is also heading NASA's plans to return the shuttles to flight, possibly as early as this fall. Web posted. (2003). [NASA Looks to Keep Shuttles Flying Until 2022 [Online]. Available WWW: <http://www.reuters.com/> [2003, March 24].]

◆ The probe into the space shuttle Columbia disaster will continue in Cape Canaveral this week as investigators focus on practices at Kennedy Space Center and efforts to recover and analyze wreckage from the Feb. 1 accident. In public hearing Tuesday (March 25), the Columbia Accident Investigation Board will hear a briefing on safety and mission assurance measures at the center where Columbia launched Jan. 16. The board wants basic information on how things work at KSC. The next day, investigators will hear testimony on the recovery and analysis of more than 43,000 pounds of shuttle wreckage that has been found in an area that stretches from south of Dallas to Louisiana. Independent aerospace experts will describe methods that could be employed to analyze the debris as part of the larger effort to pinpoint the cause of the accident. Board spokesman Air Force Lt. Col. Tyrone Woodyard said Tuesday's hearing is designed to educate the board on the role KSC plays in the shuttle program and the type of safety and mission-assurance programs in place at the spaceport. Witnesses Tuesday will include KSC Director Roy Bridges; Bill Higgins, chief of NASA's shuttle processing safety and mission assurance division at KSC; and retired Air Force Lt. Gen. Aloysius Casey, an independent consultant considered an expert on space systems, launch vehicles and aircraft. Four witnesses will testify Wednesday, including Mike Rudolphi, deputy director of NASA's Stennis Space Center in Bay St. Louis, Miss., and Steve Altemus, a NASA Shuttle Test Director at KSC. Web posted. (2003). [Columbia Board Moves Public Hearings to Florida This Week [Online]. Available WWW: <http://www.space.com/> [2003, March 24].]

MARCH 25: The space shuttle should fly again, but only on missions that can't be done any other way and with as few astronauts on board as possible, an aerospace expert said Tuesday. Retired Air Force Lt. Gen. Al Casey told the board investigating the Columbia disaster that NASA's shuttles are too complex to get much safer than their current successful flight rate of 98 percent, with two fatalities in 113 missions. That percentage "is pretty good, but in fact, I don't think it's good enough for optional human flight operations," Casey, a consultant who was commander of the space division of the Air Force Systems Command, told the Columbia Accident Investigation Board. The board held its first scheduled hearing in Florida near NASA's Kennedy Space Center, where shuttles are prepared for flight, launched and return to Earth. At the same time Tuesday, the Aerospace Safety Advisory Panel presented its 2002 report to agency chief Sean O'Keefe, saying the shuttle's age required closer inspection and "re-evaluation of certification criteria" for its parts. The panel, chartered after the 1967 fatal Apollo 1 launch pad fire that killed three astronauts, completed most of its report before the Columbia accident. But one of its recommendations -- that the National Aeronautics and Space Administration develop a better crew escape system for the shuttle -- is even more crucial in the aftermath of Columbia and the death of its seven astronauts, panel member Sidney Gutierrez said. He said the shuttle's safety rate is significantly less than originally envisioned, and NASA should expect to lose another orbiter if it continues to fly the ships for another decade or more, as the agency plans to do. "As we move forward, we need to do so with our eyes wide open," said Gutierrez,

a former astronaut and Air Force pilot. But O'Keefe cautioned the panel that it might not be possible to create an elaborate crew escape system -- and that some risk is inevitable. "The safest option I have heard is to stop flying," O'Keefe said. "This is the end question that has dominated human history. We'd still be living in caves if we said 'It's too risky to go out there; we don't want to do that.'" In Florida, Casey told investigators that NASA should not fly until the agency makes certain that shuttle systems are meeting safety margins. For example, the orbiter's external tank never was meant to shed pieces of its insulating foam during launch. Yet NASA accepted routine foam loss because it never proved dangerous. ["Safety expert wants fewer flights," **Orlando Sentinel**, March 26, 2003, p A12.]

◆ Most of the debris from shuttle Columbia is expected to be at Kennedy Space Center in four to six weeks, reconstruction coordinator Mike Leinbach said, but there's still a big job ahead. "Once it gets out on the grid, then the detailed analysis of the debris kicks in, and we're into that phase now," Leinbach said Wednesday at the hangar by the shuttle landing strip, where pieces important to the investigation are laid out on the floor. Measured in weight, about a quarter of Columbia has been found. While more than 45,000 pieces are at KSC, reconstruction director Steve Altemus said only about 1,400 are on the grid. Though they aren't being assembled three-dimensionally, a virtual 3-D reconstruction is proving helpful, Altemus told the Columbia Accident Investigation Board. The board held a second day of hearings at the Radisson Resort in Cape Canaveral on Wednesday. Now, investigators are looking at pieces on a microscopic level, analyzing melted metals and chemical reactions to learn where heat entered the orbiter's left wing, leading to its destruction upon re-entry on Feb. 1. ["Investigators hone focus of analysis," **Florida Today**, March 27, 2003, p 6A.]

◆ The House Science Committee unanimously approved legislation Wednesday calling for a memorial to be built at Arlington National Cemetery in honor of the seven astronauts killed on board the shuttle Columbia. The bill, sponsored by House Appropriations Committee Chairman C. W. "Bill" Young, R-Indian Rocks Beach, would take \$500,000 from the 2003 Pentagon budget to build a marker similar to the one that memorializes the astronauts killed in the 1986 explosion of the Challenger. Commander Rick Husband, pilot Willie McCool, payload commander Michael Anderson, payload specialist Ilan Ramon and mission specialists Kalpana Chawla, Laurel Clark and David Brown died Feb. 1 when the Columbia broke apart on re-entry over Texas. Anderson, Clark and Brown are buried at Arlington, near the Challenger memorial. ["House bill would set aside \$500,000 for Columbia memorial at Arlington," **Orlando Sentinel**, March 27, 2003, p A23.]

MARCH 27: Accident investigators have zeroed in on the exact area where launch debris hit Columbia and now will stage tests to see whether the strike could have led to the destruction of the ship. A new, three-dimensional computer analysis of launch video and still photography, unveiled Wednesday, shows a cluster of foam struck a two- to three-foot-diameter area on the leading edge of the shuttle's left wing. Three of 22 reinforced carbon carbon panels -- composite parts crucial to protecting the wing from intense re-entry heat -- were hit, as were two connecting carrier panels and adjacent underside tiles. The analysis allowed investigators for the first time to precisely plot the course debris took from the moment it broke free from Columbia's external tank about 81 seconds after the shuttle's Jan. 16 launch. It also sets the stage for a series of tests that will begin next week at Southwest Research Institute in San Antonio, Texas. "This information . . . leads us directly into testing whether or not this impact could have been the initiating event of the tragedy that followed," said G. Scott Hubbard, a member of the Columbia Accident Investigation Board. The same Texas institute carried out foam debris impact tests in 1999. NASA managers relied heavily upon those tests during Columbia's flight, ultimately deciding launch debris that hit the shuttle would not endanger its crew. The new round of tests, however, will use much larger foam debris samples, more accurately mimicking the type of debris that struck Columbia. Foam insulation from the bipod area of the tank will be employed, and a wider variety of shuttle parts will be used during the upcoming tests. Starting around April 6, a nitrogen gas gun will be used to shoot chunks of external tank foam insulation at reinforced carbon carbon panels from the prototype orbiter Enterprise and shuttle Discovery. The bipod foam comes from the area where two metal struts connect the external tank to the shuttle orbiter. ["Board to plot course of debris," **Florida Today**, March 27, 2003, p 1A & 6A.]

◆ A preliminary review of magnetic tape from shuttle Columbia's recovered flight recorder shows the device still might have been taking data seconds before the ship disintegrated, investigators said Thursday. The time-consuming job of extracting and processing actual sensor data from the recorder isn't expected to begin until the tape is delivered to NASA's Johnson Space Center in Houston this weekend. Data review will begin next week. Officials are hopeful sensor measurements from the recorder might help investigators pinpoint the cause of the Feb. 1 accident, which killed seven astronauts. About the size of a videocassette recorder, the so-called Orbiter Experiments Support System was found in a pine forest outside Hemphill, Texas, on March 19. Investigators say the device was programmed to take 271 sensor measurements from the shuttle's wings, fuselage and vertical stabilizer, or tail. ["Columbia magnetic tape may reveal final moments," **Florida Today**, March 28, 2003, p 2A.]

◆ Two Brevard County men and a South Dakota man were injured when a search helicopter went down over a shuttle Columbia debris site in east Texas on Thursday afternoon. Two others were killed. United Space Alliance employee Richard Lange and Kennedy Space Center employee Ronnie Dale were riding in a Bell 407 helicopter, helping to search for shuttle wreckage. The helicopter's pilot, J. "Buzz" Mier from Arizona, and Texas Forest Service worker Charles Krensek of Lufkin, Texas were killed in the accident. Matt Tschacher, a U.S. Forest Service worker from South Dakota, was also injured in the crash in the Angelina National Forest near the small town of Broadus, Texas. The three were treated at Memorial Medical Center of East Texas in Lufkin. Dale and Lange were listed in fair condition and Tschacher was stable, according to hospital personnel. Dale, a 12-year veteran of NASA, works on quality control for the shuttle program. Lange works on shuttle pad 39A with the cold oxygen and hydrogen tanks that give the shuttle electricity. ["Two KSC workers survive copter crash," **Florida Today**, March 29, 2003, p 1A.]

MARCH 28: Military satellites will routinely take pictures of space shuttles on future flights, under a new agreement between NASA and the National Imagery and Mapping Agency. NASA chief Sean O'Keefe said Friday that the debate over whether agency officials should have pursued such photos of the doomed shuttle Columbia persuaded him to make the change. "The fact is, we'll never end up settling this debate because we don't have it [photos]. We've decided to remedy the ambiguity," O'Keefe said. "this is a very clear statement -- whenever you have the opportunity, please take it." Under the agreement, the satellites will take pictures of the shuttle when the opportunity arises during a flight, O'Keefe said. If there is a particular problem that NASA is worried about, he said, the agency will make a specific, more urgent request. ["Satellites will snap shuttle pictures," **Orlando Sentinel**, March 29, 2003, p A1 & A25.]

◆ NASA plans to release 500 pages of e-mails relating to Columbia's final mission. The e-mails, most of which were written by Johnson Space Center employees, capture a wide range of discussions about STS-107, from requests for spy satellite imagery and concerns about tank debris, to other technical issues -- such as a humidity problem inside the shuttle's research module -- that are not implicated in the accident. The e-mails will be released March 31 on the space agency's website. NASA Administrator Sean O'Keefe said there are no shocking new revelations in the e-mail traffic and many of the e-mails have already been released to the media. Web posted. (2003). [NASA to Release 500 Columbia-Related E-Mails [Online]. Available WWW: <http://www.space.com/> [2003, March 28].]

MARCH 29: The nation's top spaceflight official said lingering questions about the safety of Columbia and its crew should have reached higher-level managers than they did. But he stressed that communication and safety decisions at NASA are vastly different -- and better -- today than before the doomed 1986 Challenger launch. Bill Readdy, a former astronaut and NASA's associate administrator for spaceflight, sees few if any unhealthy trends in the way engineers dealt with questions about damage to Columbia while it orbited Earth. "We have pursued a safety culture that encourages people to speak up," Readdy said. Nevertheless, he will receive proposals Tuesday to improve the way engineers solve problems during missions and possibly to expand the number of senior managers told about lingering safety questions. During Columbia's mission, engineers had doubts about an official finding that the shuttle's damaged heat shield posed no safety issue. "If there was a question about it, maybe that should have been bumped up a level or two," Readdy said. He objected to the idea that engineers who concluded the shuttle was safe despite damage to its wing had demonstrated a form of success-based optimism. NASA was criticized for that in the past. "That's sharpshooting it too much," he said. "There was no group-think here." He also pointed out that between each of those past missions, NASA worked hard to fix and improve the shuttle.

Readdy acknowledged NASA culture demands numbers for decisions. He even referred to a sign that hangs in the mission-evaluation room at Johnson Space Center: "In God we trust. All others bring data." But he said engineers with safety questions never have the burden to provide data and prove their safety concerns are real. Meanwhile, the specially appointed Columbia Accident Investigation Board has interviewed 25 to 30 people in efforts to understand communication and decision making inside NASA. "It's very subjective," said board member Maj. Gen. Kenneth W. Hess, commander of the U.S. Air Force Safety Center. "The people at NASA are very confident in how they handle safety discussions." ["'Culture encourages people to speak up'," **Florida Today**, March 30, 2003, p 11A.]

◆ The type of "what-if" discussions that led engineers to uncanny predictions of the Columbia disaster was unlikely to leave their inner circle, since they rarely question colleagues outside their area of expertise. Flight controllers say they didn't question the Boeing analysis of foam debris that hit the shuttle during its ascent. They accepted its conclusions that the ship would survive, even as they discussed the possibility of heat damage or a fatal landing while the orbiter was in flight. "In one sense, people do need to stick to their expertise," said Bob Daugherty, the expert in landing dynamics at NASA Langley Research Center whose dire scenarios while Columbia was in flight prompted so much discussion. "That's why I'm not out there talking about tiles and thermal protection, because I just don't know it. We thought that the experts had been engaged down at JSC and they were on top of it," said Mark Shuart, director of structures and materials at Langley. Shuart said it's difficult to include people with broad knowledge of a number of systems in technical discussions because their knowledge of each discipline isn't as deep. Discussions among the mechanical systems engineers, for example, probably wouldn't include tile experts. "From an engineering perspective, we try and balance that," Shuart said. People are careful when they venture outside their areas of focus. "I've had plenty of flight controllers come to me about concerns that were not in their area of expertise and give me an earful," said Wayne Hale, launch integration manager at Kennedy Space Center and a veteran flight controller. Still, he said, "I think there is certainly a knowledge that when you're outside your area, you need to be circumspect in what you say." Shuttle program manager Ron Dittmore told the Columbia Accident Investigation Board that NASA culture encourages anyone with a concern to walk into his office and tell him so. However, the Columbia discussions appear to have taken place without any sense of urgency. The flight controllers involved had a confidence in the work of their colleagues that seemed to defy the deadly scenarios they were discussing. ["What-if scenarios part of NASA's spaceflight legacy," **Florida Today**, March 30, 2003, p 11A.]

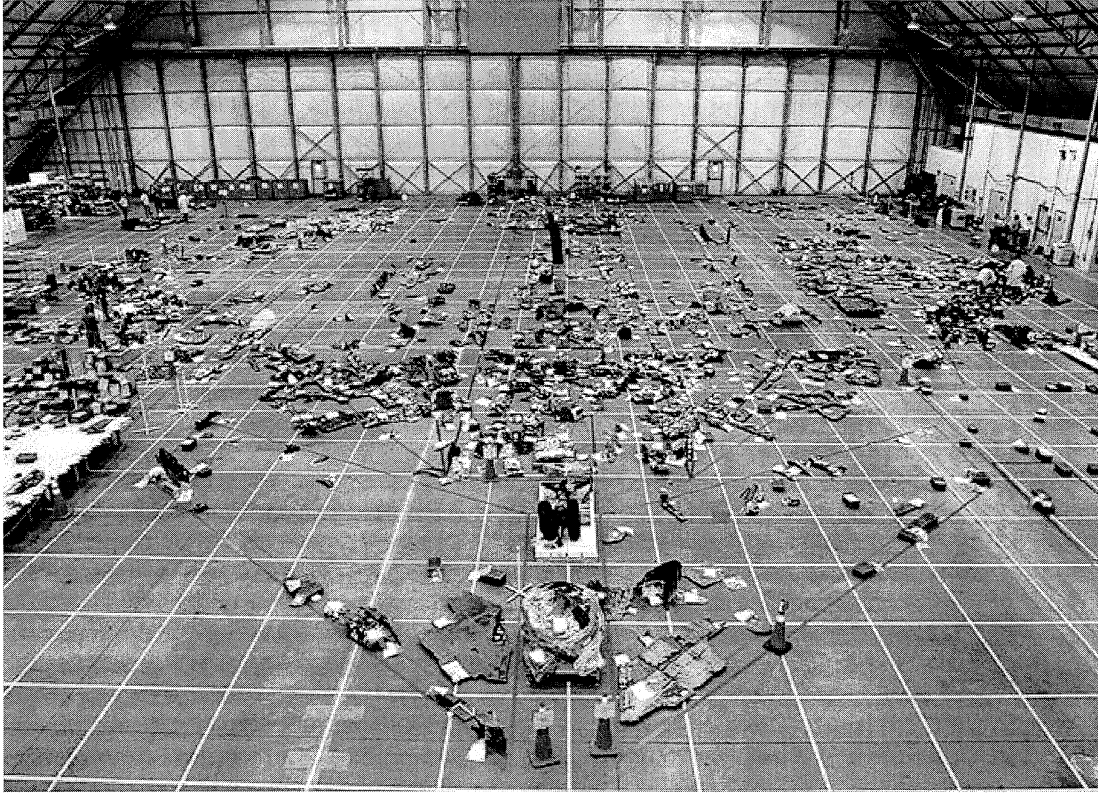
MARCH 31: The NAVSTAR Global Positioning System 2R-9 spacecraft rode a three-stage version of Boeing's Delta 2 rocket from launch pad 17A at Cape Canaveral Air Force Station. Liftoff occurred 15 minutes late due to Range Safety issues. Web posted. (2003). [Delta doesn't disappoint in successful GPS launch [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 31].]

◆ Ongoing analysis of a "treasure trove" of data from a recorder recovered in the wreckage of the shuttle Columbia shows a deadly plume of super-heated air first began eating its way into the ship's left wing just five minutes after the orbiter fell into the discernible atmosphere. The sudden temperature increase, in a cavity behind the U-shaped panels making up the leading edge of the left wing, came a full three minutes earlier than previous telemetry indicated the start of unusual heating. Entry interface occurred at 8:44:09 a.m. and a sensor mounted on a brace behind leading edge panel No. 9 began responding to a very sharp temperature increase at 8:49:09 a.m., nearly two minutes before the shuttle entered the region of maximum heating (this is earlier than officials reported Sunday evening based on quick-look data analysis of the OEX data). In any case, exactly three minutes after that initial temperature rise, the sensor failed and dropped off line after detecting a temperature of 450 degrees Fahrenheit. Eight seconds later, at 8:52:17 a.m., a sensor mounted on a brake line in the left main landing gear wheel well recorded the start of an unusual temperature rise. Harold Gehman, chairman of the Columbia Accident Investigation Board, said today the timing of these events suggests Columbia began its re-entry with a fatal flaw that allowed hot gas to first enter the cavity behind the leading edge panels and then to burn its way into the interior of the wing. The hot gas presumably entered the wheel well through a vent on its forward face, triggering the brake line temperature increase. A few seconds later, beginning at 8:52:49 a.m., a sensor mounted on the forward interior edge of the wing, just behind the failed sensor in the leading edge cavity, began registering a rapid increase as hot gas shot through the interior. Seven seconds after that, data from sensors mounted toward the back of the wing began dropping off line as the plume burned its way through a wire bundle routed

around the outside of the landing gear wheel well. "Now interestingly enough, the first temperature rise we see inside the wheel well occurs at 52:17," Gehman said. "Just about the time the sensor outside the wing spar fails, the temperature inside the wing spar starts to go up. So this is interesting to us." The sensor mounted on the inner surface of the wing spar roughly behind leading edge panel No. 9 "starts to rise 520 seconds after EI, which is something like eight minutes and 40 seconds, which would make it something like 52:49," Gehman said. "The temperature sensor inside the wing starts to rise almost coincidentally with the time the temperature sensor outside the spar goes off line, which leads you to believe there was a whole lot of heat outside the spar which finally ate its way into the wing. "Remembering the melting temperature of aluminum is something like 900 degrees, it got really hot outside the spar, ate its way through and the temperature sensor outside the spar goes off line," he said. "It probably got destroyed." Enhanced video of Columbia's launching shows a suitcase-size piece of foam debris from the shuttle's external fuel tank pulled away and slammed into the left wing about 82 seconds after liftoff. The two-foot-wide impact footprint is centered on reinforced carbon carbon - RCC - leading edge panel No. 6. The impact could have affected two adjacent RCC panels as well as protective tiles atop so-called "carrier panels" marking the interface between the lower edge of the RCC panels and permanent heat-shield tiles on the lower surface of the wing. Gehman said the temperature data recovered from Columbia's orbiter payload experiments recorder, or OEX recorder, does not rule out or confirm an initial breach at or near RCC panel 6. Web posted. (2003). [Gehman calls recorder data a 'treasure trove'[Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, March 31].]

◆ Inside the hangar where NASA has collected wreckage from shuttle Columbia, engineers and scientists have strung up a banner signed by dozens of school kids, who wrote in large block letters, "We honor the crew of the Columbia." Behind that banner is a special room where NASA allows no visitors. It's where investigators keep the wreckage of the crew compartment and the astronauts' personal items. Positive identification of the remains for all seven astronauts was made at a military base in Dover, Del. NASA is closely holding information about how the astronauts might have perished in the tragedy. "For people at the Kennedy Space Center, we love the orbiters," said Mike Leinbach, the engineer who is running the reconstruction work on the orbiter three shifts a day, seven days a week. It becomes part of our family that we have crawled through and sweated on. We feel we have lost a family member. It is hard to describe." Even harder to deal with are the pieces of wreckage that comprise the accident's death scene. Leinbach said he allows only investigators with a direct need to know in to the room and rejects any discussion of what is inside, saying it would offend the astronauts' families. ["NASA guards sensitive wreckage," **Florida Today**, March 31, 2003, p 9A.]

◆ Flight controllers and the Columbia crew had options for changing their re-entry plans, if engineers had obtained solid information about damage to the shuttle's wing and heat shield, records show. Spy-satellite photos might have provided such information. And a leader of the team that assessed the damage from a debris strike thought it was "bordering on irresponsible" that the shuttle program did not request spy-camera photos of shuttle Columbia in orbit, e-mail records show. Rodney Rocha, chief structural engineer at NASA's Johnson Space Center, described three options for a damaged shuttle. They included constraining right- and left-hand turns during a phase of re-entry if the shuttle's protective carbon panels were damaged enough they affected flight control. Engineers knew right away Columbia suffered damage during launch Jan. 16 when a piece of foam insulation broke free from the huge fuel tank and smashed into the left wing. But without photos of actual damage, engineers relied on computer models and data from past shuttle flights. "Their answers may have a wide spread, ranging from acceptable, to not-acceptable to horrible, and no way to reduce uncertainty," Rocha wrote in a Jan. 21 request to NASA managers for spy-agency photos. "Can we petition (beg) for outside agency assistance?" Senior mission and shuttle program managers declined to request the photos, records show, waiting instead for a briefing and a Jan. 26 team analysis — authored by Rocha — that found the shuttle faced no danger. The photos never came. NASA on Monday released more than 1,000 pages of e-mail messages requested under the Freedom of Information Act. ["Data would have given astronauts re-entry options," **Florida Today**, April 1, 2003, p 1A & 2A.]



The overview of the floor of the RLV Hangar at KSC shows a small portion of the debris collected and shipped to KSC to date. The major Columbia recovery efforts in East Texas have produced more than 70,000 pieces, about 40 percent of the Space Shuttle by weight.

APRIL

April 1: As the search of more than 500,000 acres of primary recovery area for Space Shuttle Columbia material reached its halfway mark, NASA Administrator Sean O'Keefe visited key sites in east Texas to thank recovery crews for their diligence and hard work. Approximately 4,500 ground searchers have covered approximately 56 percent of the planned 555,000-acre search area. The air search has covered approximately 74 percent of 604 four-square-nautical-mile grids; and, on water, searchers have scanned about 81 percent of a planned 14.7-square-nautical-mile area. The search should be completed within four to six weeks, weather permitting. Searches farther west, along Columbia's ground track, likely will take additional time, because of the great area involved. About 28 percent of the Shuttle Columbia, by weight, has been delivered to the RLV Hangar. ["Primary Search For Columbia Material Passes Halfway Mark," **KSC Countdown**, April 1, 2003.]

◆ Paint primer from shuttle launch towers may have splashed with rain onto Columbia and formed pinholes in the leading edge of the left wing that contributed to the disaster, the investigation board says. Such corrosion over the years could have weakened the carbon panels along the edge enough to break when struck by a chunk of foam during liftoff, the accident investigators said Tuesday. "We're studying the effects of aging," said the board's chairman, Harold Gehman Jr. Air Force Maj. Gen. John Barry said pinholes in the quarter-inch-thick protective carbon lining the edge may have allowed air pockets to form. The air could have gnawed away at the carbon, a process called oxidation. The pinholes have appeared on all four space shuttles. NASA patched the larger holes, but did not check thoroughly for underlying air pockets, investigators said. The accident investigation board is trying to determine what caused Columbia's destruction over Texas two months ago Tuesday. Barry and other members have focused from the start on the left wing, which was hit by debris barely a minute after liftoff. Web posted. (2003). [Shuttle investigation turns to role of paint primer [Online]. Available WWW: <http://www.cnn.com/> [2003, April 2].]

◆ An object that detached from the space shuttle Columbia on its second day in orbit resembled a carrier panel from near the leading edge of a wing, investigators said yesterday. The evidence from Air Force radar analysis fits with a growing body of data indicating that the orbiter's left wing was damaged before it began its Feb. 1 reentry into the atmosphere. Investigators believe the damage created an opening in the orbiter's heat shield that allowed superheated air to burn its way into the structure, with disastrous results. The carrier panels serve as a bridge between the ceramic tiles that cover the orbiter's underbody and the larger carbon fiber panels -- shaped something like horseshoes -- that are bolted to the wings' leading edge to protect against the hotter temperatures that build up there. Following extensive analysis of 29 shuttle materials, "we've concluded that, right now, only the carrier panel remains a viable candidate for the Day Two object," said Maj. Gen. John L. Barry, a member of the Columbia Accident Investigation Board, at a Houston briefing yesterday. However, the picture shifted again soon after the briefing ended, when engineers analyzing shuttle wreckage delivered to Kennedy Space Center identified a carrier panel from the bull's-eye area of the wing where investigators believe the initial breach may have occurred. It was carrier panel number 6 and appeared to be in good shape, a member of the board said later. "That means that not a whole lot burned around it," he said. "It probably means the carrier panels on either side didn't burn." The development cast fresh doubt on the radar object's identity, he said, and indicated that "this is a detective story. Now we have one more part of the puzzle. It's a long, long process." The team previously identified 10 other carrier panels and is still looking for panels number 5, 8, 9 and 12. The mystery object that drifted away from the shuttle in space was detected in extensive post-accident studies of about 3,100 radar images that Defense Department trackers took of orbiting objects during the mission, prompting fleeting speculation that a piece of space junk or a micrometeoroid had struck Columbia. To identify the object, the investigating board sent samples of 29 shuttle materials to Wright-Patterson Air Force Base in Ohio, where analysts have been studying the "signatures" of their radar reflections to try to match one with the object seen in orbit. Web posted. (2003). [Columbia Investigation Zeroes In on Carrier Panel [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, April 2].]

◆ A veteran shuttle commander will head a NASA team preparing to get the grounded orbiters flying again. Jim Halsell, Jr., who has logged more than 1,250 hours in space on five shuttle missions, was named Tuesday to lead the space agency's "Return to Flight Team." Halsell, 46, was most recently the manager of shuttle launch integration at Kennedy Space Center. He is on the manifest to fly STS-188, a shuttle mission to the International Space Station scheduled for later this year. Halsell's appointment coincided with an April 1 deadline set by William Readdy, NASA associate administrator for space flight. Three weeks ago, Readdy sent a memo to senior managers and space flight center directors, requesting they formulate a plan of action to implement recommendations likely to come from the Columbia Accident Investigation Board. Readdy instructed the Return to Flight Team to prepare for a launch opportunity as early as fall 2003, but that date is seen as highly unlikely. Many expect it could be summer of 2004 or later before the shuttles fly again. ["NASA names shuttle leader," **Florida Today**, April 2, 2003, p 3A.]

April 2: Over 50 members of the Kennedy Space Center workforce have been called to active duty to protect America overseas. The servicemen and women represent many different divisions and employers at KSC, including NASA, United Space Alliance, Boeing, Space Gateway Support, as well as other NASA contractors. Thirty-one KSC employees have been called to active duty in the Air Force, while 11 are currently serving in the US Army. The Coast Guard and Navy have both called 3 members of KSC's workforce into service. ["Members of KSC Workforce Defend Country Abroad," **KSC News Release #26-03**, April 2, 2003.]

April 3: Workers at the Kennedy Space Center Visitor Complex were preparing for a possible strike after rejecting the latest contract offer by Delaware North Parks Services of Spaceport, the company that runs the park for NASA. However, the union representing many of the workers at the Visitor Complex is waiting for another offer from the company before calling a strike. "We turned down the proposal, and they (in management) have an opportunity to fix it," Jeff Rainey, business representative for the International Association of Machinists and Aerospace Workers District 166/Local 773, said Thursday. Dan LeBlanc, the chief operations officer for Delaware North at the Visitor Complex, said he expects representatives for the company and the workers to meet soon, perhaps early next week, to work out an agreement and avoid a strike. About 300 of the 650 to 700 workers at the Visitor Complex are represented by Local 773, while others are members of other unions or are independent. ["Visitor Complex workers may strike," **Florida Today**, April 4, 2003, p 1C.]

◆ Russia pledged extra money Thursday for building the only spacecraft to service the International Space Station after U.S. shuttle flights were grounded following the Columbia disaster. Russia previously said it could not fund such construction on its own. The Cabinet's decision to release \$38 million ahead of schedule appeared to reflect growing doubts that the United States will provide extra assistance. ["Russia boosts funding for space station flights," **Florida Today**, April 4, 2003, p 9A.]

April 4: Retired NASA/Kennedy Space Center engineer and inventor Adam Kissiah will be officially inducted to the Space Foundation's Space Technology Hall of Fame next week for helping thousands of individuals to hear, some for the very first time. Kissiah developed the cochlear implant concept more than 25 years ago while working at Kennedy Space Center utilizing knowledge he acquired working with the Space Shuttle program, particularly electronic sensing systems, telemetry, and sounds and vibrations sensors. The Cochlear Implant Association estimates over 66,000 patients have received an implant in this \$1.65 billion industry. ["NASA Engineer Kissiah Inducted To Space Technology Hall of Fame," **KSC News Release #27-03**, April 4, 2003.]

◆ Providing premier base support services to the Cape Canaveral Spaceport is Susan Kroskey's main objective in her new role as executive director of the Cape Canaveral Spaceport Management Office (CCSMO). Effective April 6, 2003, Kroskey will assume this Senior Executive Service (SES) position, managing the Joint Base Operations and Support Contract (J-BOSC) for KSC and the 45th Space Wing (CCAFS and PAFB). She will report to Kennedy Space Center Director Roy Bridges and to the 45th Space Wing Commander Brig. Gen. J. Gregory Pavlovich. ["Kroskey Named Executive Director, Cape Canaveral Spaceport Management Office," **KSC News Release #28-03**, April 4, 2003.]

◆ NASA is studying three options for a major redesign of an area on the space shuttle's external fuel tank where debris broke loose and struck Columbia during launch. March 26 briefing documents from the National Aeronautics and Space Administration detail proposed changes to a pair of foam insulation ramps near the tank's midsection. The suitcase-sized ramps cover metal fittings in the so-called bipod area, where a pair of struts mate the orbiter to the 15-story tank. Two of the options would shrink the foam ramps and eliminate some related hardware. Another would replace the ramp entirely with a metal housing. The goal is to make sure large pieces of debris don't fall from the area and hit the shuttle again. A chunk of foam estimated to weigh more than 2 pounds broke free from the same spot 82 seconds after Columbia's Jan. 16 launch and struck near the leading edge of the orbiter's left wing. Investigators probing Columbia's Feb. 1 breakup over central Texas suspect the debris impact -- considered the largest ever -- caused damage that led to a fatal breach in the ship's protective heat armor during re-entry. Before Columbia's launch, tank engineers already were working on a modest redesign of the ramps, after foam came loose from the same spot during Atlantis' liftoff in October. At least three earlier shuttle flights, the most recent in 1992, also had lost large pieces of foam from the bipod area. Two changes were under way. One was removal of a silicon-based insulating material called an ablator that was applied to the tank before foam was sprayed on to form the ramps. Air pockets occasionally formed between the foam and ablator, making it easier for the foam to come loose. The other change would have given workers more time to spray on the foam and build up the ramps to ensure a more consistent manufacturing process. After the accident, a Feb. 27 letter from shuttle-program manager Ron Dittmore directed the tank project at Marshall Space Flight Center in Huntsville, Ala., to "review the ET [external tank] bipod area and recommend changes to the ET insulation design and implementation to preclude any loss of insulation." That review has yielded more ambitious ideas for a ramp redesign. Dittmore's directive was aimed at returning the shuttle to flight as early as possible. To make that happen, tank engineers plan to be poised to move ahead with more extensive changes as soon as the Columbia Accident Investigation Board issues its recommendations, which are expected sometime in June. Web posted. (2003). [NASA studies 3 ways to improve fuel tanks [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, April 5].]

◆ Researchers shot a chunk of real shuttle foam insulation at an aluminum sheet Friday to prepare for tests later this month requested by the Columbia accident investigators. The investigation board wants to measure the amount of damage caused by insulating foam striking actual shuttle wing parts at nearly 500 mph. These test-firings at Southwest Research Institute should help determine whether the blow to Columbia's left wing by a 2-pound piece of foam during liftoff was enough to lead to the ship's destruction two weeks later. NASA called the institute for help in setting up the tests two days after the shuttle disintegrated over Texas during re-entry. For the month long series of tests scheduled to begin in mid-April, NASA will shoot foam at wing panels from the shuttle Discovery and the Enterprise, a prototype that never flew and is now housed at the Smithsonian Institution. ["Investigators prepare for shuttle testing," **Florida Today**, April 5, 2003, p 2A.]

April 6: NASA engineers have worried about space shuttle damage from launch debris "since day one" but acknowledged Monday that 22 years of incremental fixes have done little to lessen the extent of the problem. Testifying before the Columbia Accident Investigation Board, two engineers detailed a long history of debris breaking free from shuttle external fuel tanks resulting in damage and efforts to resolve the problem. Their charts showed shuttles have regularly returned to Earth with dozens, and sometimes hundreds, of damaged spots on fragile heat shielding that protects the ships and their crews from deadly heat during atmospheric re-entry. The chairman of the investigation board was quick to note the number of debris strikes greater than 1-inch -- an arbitrary size used by NASA to track damage -- largely has remained between 16 and 20 over the course of the shuttle program. "The point is that the trend is not going down, not by any order of magnitude," said retired Navy Adm. Harold W. Gehman Jr. "Correct," replied J. Scott Sparks, a lead engineer in the External Tank Project Office at NASA's Marshall Space Flight Center in Huntsville, Ala. The exchange took place during the latest in a series of public hearings in the investigation into the Feb. 1 loss of Columbia and its seven astronauts. Another hearing is scheduled today. Damage from launch debris, particularly foam insulation falling off shuttle external tanks, has been a key focus of the board. A suitcase-sized cluster of foam broke off Columbia's external tank 81 seconds after its Jan. 16 launch. It struck the shuttle's left wing near the spot where investigators believe hot gases penetrated the ship during re-entry, triggering its destruction. Lee D. Foster, an engineer with the Vehicle and Systems Development Department at Marshall, said the debris problem has been a concern since a pockmarked

Columbia returned to Earth at the end of NASA's first shuttle mission in 1981. Web posted. (2003). [Engineers: Launch debris troublesome since start [Online]. Available WWW: <http://www.floridatoday.com/> [2003, April 7].]

April 7: The reel-to-reel tape recorder is approaching 35 years old. It dates from an era of eight-track car stereos; it's less advanced technologically than the videocassette recorder that sits in your living room; and it was abandoned long ago by the scientists who ordered it installed as original equipment on shuttle Columbia. But today, this low-tech relic, with its 9,200 feet of magnetic recording tape, is providing NASA and the board investigating the Columbia disaster with a detailed look at what happened aboard the shuttle in the minutes before it broke apart over Texas on Feb. 1. "I was really surprised to hear this thing -- one of my pets -- was flown and then found," said retired National Aeronautics and Space Administration engineer Robert L. Giesecke, who wrote specifications for the recorder in the late 1970s and assumed it had been replaced after he left the agency in 1995. "By the 1990s, it was obsolete." Found resting on a bed of leaves on a Texas hillside, the recorder -- which was turned on as Columbia began its re-entry of Earth's atmosphere -- is gradually offering up a detailed picture of how superhot gases penetrated and ultimately melted the orbiter's left wing. Data from some of the roughly 670 still-functioning sensors show heat began building up in the wing just 80 seconds after Columbia began its re-entry. That's more than three minutes before the orbiter's space-to-ground telemetry registered a temperature increase, board member Roger Tetrault said. Board Chairman Harold W. Gehman Jr. has called the recorder readings a "treasure-trove." ["Key clue may be on '70s recorder," **Orlando Sentinel**, April 7, 2003, p A1 & A7.]

◆ Two months after the shuttle Columbia shattered in the skies over Texas, accident investigators have considered every possible theory, no matter how wild -- a killer micrometeorite, some sort of high-altitude electrical zap and even the scientific experiments on board. Yet the strongest theory still seems to be the one that emerged the first day -- the theory that foam insulation ripped off the fuel tank just after liftoff and smashed somewhere on the shuttle's left wing, causing enough damage to lead to disaster. "This is the leading contender, but we don't have the final proof," said Scott Hubbard, a member of the Columbia Accident Investigation Board and a high-ranking NASA official. Two weeks of investigation since the February 1 accident that killed seven astronauts have mostly uncovered more evidence backing that original theory. NASA knew early in Columbia's 16-day mission that foam debris had broken off the fuel tank and hit the left wing. But mission officials had concluded it did not pose a danger. A tape from an old-fashioned reel-to-reel data recorder that was pulled from the Texas mud revealed that heating problems that developed during Columbia's return to Earth began much earlier than thought. The recorder detected an unusual warming trend in the left wing barely a minute after the shuttle first hit Earth's atmosphere over the Pacific. To investigators, that is evidence that Columbia was mortally wounded and that plumes of scorching air had entered a pre-existing gash in the left wing which started burning through. The have been unable to come up with a plausible theory that the gash in the wing came from space junk or something else in orbit, leaving the foam strike as the most likely culprit. Web posted. (2003). [Shuttle investigators ponder theories [Online], Available WWW: <http://www.cnn.com/> [2003, April 7].]

◆ NASA managers Monday defended how the agency dealt with foam coming loose from shuttle external tanks during launches and hitting the orbiters, saying the problem was studied intensely and that changes were made when possible. Foam debris caused an average of 13 to 25 1-inch dings in the shuttle's thermal-protection tiles on every flight -- and occasionally many more, experts said at a public hearing convened by the Columbia Accident Investigation Board. But the damage never was serious enough to be considered a risk to crew safety, said Lee D. Foster, and external-tank expert with the agency's Marshall Space Flight Center in Alabama. "Again, everything was judged as a maintenance item and not as a safety-of-flight item," Foster said. "I'm not going to say whether that was right or wrong in the past, but that's the way it happened." Shuttle Columbia suffered a blow to its left wing shortly after its Jan. 16 launch from Kennedy Space Center after a large piece of foam came loose from the bipod region of the tank -- an attachment point between the orbiter and the tank. Investigators think the incident may have caused damage that allowed hot gases to seep inside Columbia's left wing during its re-entry to the atmosphere, eventually causing the ship's destruction. The sprayed-on foam ranges from just an inch in thickness to a foot in one area called the bipod ramp. It insulates the 15-story fuel tank, which is full of supercold liquid propellant. Experts testifying Monday said the foam had broken off the bipod region on at least four occasions before Columbia's mission, including an October flight of shuttle Atlantis. Those four known

incidents were spread over the years: 1983, 1990, 1992, and Atlantis' flight in 2002. After each of the first three times, NASA made small changes in how the Styrofoam-like polyurethane was applied that alleviated the problem, Foster said. Officials decided there was no reason to stop flying while the agency redesigned the bipod region and made other improvements. ["NASA defends its handling of foam problems,"

Orlando Sentinel, April 8, 2003, p A5.]

April 8: Harold Gehman, chairman of the Columbia Accident Investigation Board, said today two interim recommendations will be released late this week or early next and that the panel likely will write its final report in June. Gehman also said "privileged," or confidential testimony from senior shuttle managers, engineers and technicians, will never be made public, either in a public hearing or in final report transcripts. "If a witness under privilege tells us that a board meeting was a sham and people weren't free to speak up or something like that, then we will corroborate that, which will see the light of day," Gehman said in a brief interview following a news conference. "But as far as the public hearings are concerned, the public hearings are essentially board meetings in public. That's what we do all day long. We interview, we talk to people like that and it's simply an opportunity for the public to see how we work and go along with us. I mean, you're learning at the same time we're learning. It's not a press event, it's not a news event, it's just an opportunity to do some of our business in public. And that's the intent of it." The CAIB is interviewing senior shuttle managers and engineers under conditions of confidentiality. By granting such privileged status, the board guarantees witnesses their testimony will never been made public and that criticisms of systems, procedures or other individuals will not be traceable. The idea is to encourage a more open, more honest dialogue with board members and investigators. Under this policy, the public will never hear directly from Linda Ham, for example, chairman of NASA's mission management team during Columbia's flight, or any other managers responsible for deciding what to do about the foam impact during launch that is now believed to have played a major role in the disaster. Asked if conducting such interviews in secret might represent a disservice to the public, Gehman said "we consider this to be a strength, not a weakness." Web posted. (2003). [No 'privileged' testimony or transcripts to be made public [Online], Available WWW: <http://www.spaceflightnow.com/> [2003, April 8].]

◆ The nation's shuttle fleet could return to flight before the end of the year, NASA Administrator Sean O'Keefe told a congressional panel Tuesday. O'Keefe's guarded but optimistic assessment was apparently based on signals and statements he said the Columbia Accident Investigation Board has sent at public hearings and elsewhere. "It is my fondest expectation that, if there are no showstoppers on the hardware end, the opportunity to return to flight (will be) by the end of the calendar year," O'Keefe told members of the House Appropriations subcommittee that controls NASA's budget. The space agency chief thinks the independent investigation board is just weeks from recommending improvements to hardware and procedures needed to make the remaining three shuttles safe to fly. "We haven't heard a date at this point," NASA spokeswoman Tracy Young said at Kennedy Space Center. O'Keefe said NASA managers and engineers are pursuing solutions to failures the investigation board has highlighted. Among them: fixing the foam insulation on the shuttle's external tank. ["O'Keefe expects shuttle launch this year," **Florida Today**, April 9, 2003, p 1A & 3A.]

◆ NASA might have made the same type of errors in judgment before the Feb. 1 Columbia disaster that the agency made before the Challenger explosion in 1986, an accident investigator said Tuesday. In the 22 years leading up to Columbia's ill-fated flight, investigator Sally Ride said NASA grew to treat persistent damage to critical shuttle heat shielding as an acceptable risk, despite agency requirements to preclude such damage. The former astronaut, who became the first American woman in space in 1983, also noted the booster rocket O-ring problem that ultimately doomed Challenger was handled in much the same manner. "I think I'm hearing an echo here," said Ride, who also served on the Rogers Commission that investigated the Challenger explosion. Shuttle O-rings "had been a problem on not just one, not just two, not just three, but several shuttle flights before the Challenger accident," she said. "We're trying to understand whether that same thinking crept in with the foam off the tank," Ride said. A two-pound piece of foam insulation broke free from Columbia's external fuel tank 81 seconds after the shuttle's Jan. 16 launch. Investigators also noted that NASA contractor engineers relied on a "rudimentary" computer model when they determined that damage done to Columbia's wing would not endanger the ship or its crew during atmospheric re-entry. Board chairman Retired Navy Adm. Harold Gehman said the panel is "not satisfied" that the model was "good enough" to accurately gauge the damage. What's more, Ride said the model never

had been used as a decision-making tool during a shuttle flight. Both Gehman and Ride, however, stopped short of condemning the actual work done by NASA in assessing the problem while Columbia was in orbit. "We have not concluded that the analysis and the decision-making was wrong," Gehman said. ["Judgment errors similar to Challenger, Ride says," **Florida Today**, April 9, 2003, p 3A.]

April 9: The launch of NASA's Space Infrared Telescope Facility aboard a Boeing Delta II Heavy expendable launch vehicle is scheduled for Friday, April 18, at the opening of an instantaneous launch window that occurs at 4:32:49 a.m. EDT. Launch will occur from Pad 17-B on Cape Canaveral Air Force Station. The Space Infrared Telescope Facility marks the finale of NASA's Great Observatories Program, which includes the Hubble Space Telescope, the Chandra X-ray Observatory and the Compton Gamma Ray Observatory. Its unprecedented infrared sensitivity will allow astronomers to study the most distant, coldest, and most dust-obscured objects and processes in the universe. ["Space Infrared Telescope Facility (SIRTF) to be Launched Aboard Delta II April 18," **KSC News Release #29-03**, April 9, 2003.]

◆ NASA relied on an unsophisticated computer program that never had been used before to evaluate damage to shuttles in orbit to decide Columbia's return to Earth was not jeopardized by a debris strike during launch. The program, called Crater, had previously been used after shuttles had landed and engineers could examine damage to their heat-protective tiles. Crater then was employed to estimate the size of debris that likely had struck the orbiters, investigators said Tuesday. But in Columbia's case, NASA applied the program in reverse, relying on Crater to predict the severity of damage inflicted by a 2-pound piece of foam that came off the shuttle's external fuel tank and struck the left wing. The incident was captured on launch-day video and analyzed by engineers during the flight. In hindsight, the space agency was led to the "obviously . . . wrong" conclusion that Columbia was not seriously harmed by the incident, said Harold Gehman Jr., chairman of the Columbia Accident Investigation Board. The board now suspects that the foam may have breached the thermal-protection system, allowing superhot re-entry gases into Columbia's left wing. "The model has a lot of limitations. It's not really a computational model. It's just a bunch of data based on previous experience and some testing," Gehman said. "Neither NASA or [the board] are satisfied that this model is good enough for what we need it for." Crater is a spreadsheet that matches the size of debris strikes with damage to the orbiter's protective heat tiles based on tests and observations from previous shuttle flights. Engineers fired chunks of foam, mostly 1-by-3 inches, at pieces of tile to create a database of likely damage. By contrast, the chunk of foam that struck Columbia's left wing was estimated to be roughly 2 feet long. The board has been evaluating Crater since the Feb. 1 accident that killed seven astronauts, along with how the analysis affected the way NASA made other decisions during the ship's time in orbit. ["NASA relied on unproven program to check danger," **Orlando Sentinel**, April 9, 2003, p A1 & A4.]

◆ NASA is eager to look to the future even as it grapples with delays caused by the Columbia accident and the grounding of the remaining three space shuttles, agency head Sean O'Keefe told a congressional budget committee Tuesday. The space program must continue, he said, with a careful balance of manned and unmanned missions to minimize risk while using astronauts to perform essential tasks. "Something went dangerously wrong," O'Keefe said of the Feb. 1 breakup of Columbia, which killed seven astronauts. "We're going to find it, fix it and return to flying safely. But to ignore the objective for exploration and discovery would be a step backward." Amid questions about the future of the shuttle program, the international space station and efforts to build new spacecraft to supplement the shuttle, the House Appropriations subcommittee that controls the agency's purse strings took a first look at NASA's \$15.47 billion request for 2004. U.S. Rep. James Walsh, R-N.Y., who heads the subcommittee, said the importance of spaceflight should not be diminished by the Columbia tragedy. "I suspect that if we back away from the inherent desire in humans to move forward and find new horizons, the world would be a very different place," Walsh said. Rep. Alan Mollohan of West Virginia, the subcommittee's ranking Democratic member, said the National Aeronautics and Space Administration's predicament -- with no way to get into space until the shuttles can fly again -- highlights the need for the agency to aim higher in the future. He said NASA's budget request "continues a too-long trend for this agency" seeking too little money to do everything it wants. O'Keefe said the budget, and an accompanying blueprint for the next several years, is a "steppingstone" approach to set up long-term goals. His biggest proposal, dubbed Project Prometheus, calls for spending \$3 billion during the next five years to develop ways to convert nuclear fission into electrical power needed to send spacecraft deeper into space. He said that unless the board investigating the

Columbia tragedy presents the agency with a "showstopper," NASA hopes to return to flight as quickly as the end of this year. Several subcommittee members urged that NASA develop an alternative vehicle more quickly. Its next project, the orbital space plane, is not slated to be ready until 2012. ["O'Keefe assures lawmakers of NASA's resolve," **Orlando Sentinel**, April 9, 2003, p A4.]

April 10: The Federal Emergency Management Agency said it plans to complete its search for debris of the space shuttle Columbia as early as the end of April. The U.S. Navy is expected to finish dive operations in the search area this weekend, FEMA said in a news release Thursday. On February 1, Columbia broke apart while returning to earth, killing all seven astronauts aboard. An independent investigative team has been focusing on damage to the tiles -- possibly caused by frozen foam insulation that broke loose from the liquid fuel tank during liftoff and struck the underside of the shuttle -- as the cause of the disaster. FEMA released the following information on the search for debris as of April 9: More than 13,000 members of the ground recovery team have recovered 60,200 shuttle debris pieces over a 10-week period, after searching over 76 percent of the 621,000-acre search area. About 4,900 personnel are searching for more debris. Ground and air personnel have searched more than 2.1 million acres, which includes Western states such as New Mexico, Nevada, Utah and California. The main debris search corridor is located in Texas and is 10 miles wide by 240 miles long, stretching from Ellis County to the Louisiana border. More than 70,700 pounds of shuttle material has been shipped to Kennedy Space Center in Florida, representing 32 percent of the shuttle's total weight. More than 90 federal, state and local agencies are participating in the recovery effort. Estimated completion time for the search operations is between three to five weeks (April 30-May 14). Web posted. (2003). [Shuttle debris search finishing up [Online]. Available WWW: <http://www.cnn.com/> [2003, April 11].]

◆ NASA needs to go beyond its current visual inspections of space shuttle wings between flights, making use of high-tech tools to peer inside them for tiny flaws, according to the board investigating the Columbia disaster. In the next week, the Columbia Accident Investigation Board is expected to give the National Aeronautics and Space Administration its first two recommendations to put in place before flying again: 1) Use more sophisticated tools to examine the reinforced carbon-carbon panels that cover the edges of the shuttle's wings. Possibilities include anything from CT scans to sound waves to lasers. 2) Get satellite imagery of the space shuttles in orbit so they can be studied for potential damage during launch. NASA already has agreed to this, after failing to get such photos for Columbia, which was struck during launch by a large piece of foam that broke off the ship's external fuel tank. The board suspects that the debris damaged the edge of the orbiter's wing, causing a breach that allowed hot gases to get inside during the ship's re-entry through the atmosphere. Seven astronauts were killed in the Feb. 1 accident. The debris incident was caught on video, which shows the foam struck the left wing close to Columbia's fuselage. But new questions have emerged about what may have been damaged. During Columbia's second day in orbit, ground radar picked up an object that is thought to be a piece of the wing floating away from the spaceship. The mystery object re-entered the atmosphere, where it presumably burned up. Investigators think it may have been a so-called carrier panel -- a segment that connects the leading edge to the rest of the wing -- which had been knocked loose by the debris strike. However, searchers in Texas have found pieces from carrier panels or the insulating tiles that go on top of them from those segments closest to the shuttle's fuselage. As a result, though a carrier panel hasn't been ruled out, a board spokesman said more testing is being done to see if some other wing segment might actually have come loose. For example, "we're just having to go back and make sure that it wasn't a piece of the reinforced carbon-carbon panel that had broken off," said Lt. Col. Tyrone Woodyard, a spokesman for the board. The board's recommendation for better evaluation of the wings' leading edge is prompted by the suspicion that the carbon panels could have been more vulnerable to damage because of undetected pinholes and aging. Most of Columbia's panels were original equipment and nearly 22 years old. The reinforced carbon-carbon panels are large, U-shaped structures that wrap around the edge of the wing and are coated with a quarter-inch of special carbon insulator. There are 22 panels on each wing, providing protection for temperatures that can reach up to 2,300 degrees Fahrenheit. ["NASA's tests may add look inside wings," **Orlando Sentinel**, April 11, 2003, p A14.]

◆ NASA has released six new images captured by an Air Force telescope in Hawaii showing the shuttle Columbia in orbit days before it broke apart during its return to Earth. The images -- three photographs and three infrared images -- were studied in detail by the board investigating the disaster but appeared to be of

little use to officials. Columbia flew most of its mission upside down relative to Earth, so the images showed only the top of the space craft. Investigators suspect that Columbia suffered crippling damage to the lower part of its left wing when a 2-pound chunk of insulating foam smashed against it 81 seconds after liftoff. The six, slightly grainy images do not show obvious damage to Columbia's left wing, although details like the cockpit windshield and protective panels along the wing's edge are visible. The shuttle was orbiting at an altitude of about 172 miles. The images, quietly published weeks ago on part of NASA's Web site, were captured Jan. 28 -- four days before Columbia's breakup -- by powerful telescopes at the Air Force Maui Optical and Supercomputing Site, which is located at the crest of the dormant volcano Haleakala. The facility includes the nation's largest optical telescope for tracking satellites, the 75-ton, 3.67-meter Advanced Electro-Optical System. Telescopes at the Maui facility routinely monitor space shuttles' flights over the Pacific Ocean. Shuttle images can be seen online at <http://spaceflight.nasa.gov/gallery/images/shuttle/sts-107/ndxpage16.html> ["NASA releases new images," **Florida Today**, April 11, 2003, p 2A.]

◆ After an unseasonably nippy April day in Brevard County, the Atlas 3 rocket could not get off the ground at Cape Canaveral Air Force Station Thursday night because of wind and clouds in the area. The wind brought in thick clouds that for a time pushed back launch from its intended 8:09 p.m. liftoff time. Weather does look better for a launch April 11, with a 90 percent change of acceptable weather. The new launch time will be as early as 8:08 p.m. with another 72 minutes in the launch window. ["Wind, clouds delay Atlas 3 launch," **Florida Today**, April 11, 2003, p 2A.]

April 11: NASA has delayed the Friday launch of the Space Infrared Telescope Facility, the last of NASA's "Great Observatories," so it can review more data on its rocket. "Additional time was needed to complete internal readiness assessments," NASA spokesman Al Feinberg said. As a result, Friday's flight readiness review was delayed, pushing the launch date back to no earlier than April 26, Boeing spokesman Robert Villanueva said Friday. NASA is doing further analysis of the Boeing delta 2-Heavy's solid rocket boosters. The new launch date could put the SIRTf launch in conflict with the launch of another scientific observatory, GALEX, the Galaxy Evolution Explorer. It is set to launch on a Pegasus on April 26. ["NASA delays Friday's launch," **Florida Today**, April 12, 2003, p 1B.]

◆ NASA's independent safety board signed off Friday on the plan to reduce the crew of the international space station from three to two. The National Aeronautics and Space Administration, Russia and the other 14 international partners decided in late February to replace the current three-member crew with two people because the grounding of the shuttle fleet meant a larger crew could run short of water. The next crew, American Ed Lu and Russian Yuri Malenchenko, is scheduled to launch in a Russian Soyuz spacecraft April 26. The current crew, two Americans and a Russian, will fly home a few days later. On Friday, the Aerospace Safety Advisory Panel -- created after the 1967 Apollo 1 launch pad fire that killed three astronauts -- told NASA it had examined the potential safety issues and found that the agency's preparations were adequate. ["NASA safety panel OKs plan to reduce space-station crew," **Orlando Sentinel**, April 12, 2003, p A12.]

April 12: Adrian Laffitte is this year's recipient of the Kurt H. Debus Award presented by the National Space Club of Florida for his life of service to the space industry, including leading the inaugural launches of the Atlas 3 and Atlas 5 rockets in 2000 and 2002. Laffitte oversees Atlas Programs for Lockheed Martin Astronautics at Cape Canaveral Air Station. ["Award honors space industry worker tonight," **Florida Today**, April 12, 2003, p 1B & 2B.]

April 14: NASA has targeted Sunday, April 27 as the new launch date for the Space Infrared Telescope Facility atop the inaugural Boeing Delta 2 Heavy rocket. The \$1.2 billion mission was scheduled to fly April 18 from Cape Canaveral only to be postponed by senior agency officials to resolve concerns with the Delta 2. Although NASA has yet to explain the specific problem that prompted the delay, sources have said it involves the rocket's strap-on solid-propellant boosters. The Delta 2 Heavy uses 46-inch diameter solid motors originally developed for the more powerful Delta 3 rocket. A standard Delta 2 uses 40-inch motors. "It has been determined that additional time is needed to complete launch readiness evaluations for the Delta 2 launch vehicle prior to holding the Flight Readiness Review," NASA said in a written statement Monday. "Therefore, the launch of SIRTf is being rescheduled to occur on April 27, 2003, at 4:25:01 a.m.

EDT." Web posted. (2003). [NASA infrared observatory launch reset to April 27 [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, April 14].]

◆ Debris from space shuttle Columbia will be made available to researchers to help build better hypersonic aircraft and better spacecraft in the future, NASA announced Monday. The loan program will be similar to another NASA program in which researchers can borrow moon rocks for study. NASA has not decided whether to permit museums to display pieces of debris, but is open to the concept, said Mike Leinbach, chairman of the Columbia reconstruction team. Columbia broke apart as it re-entered Earth's atmosphere February 1. All seven crew members were killed in the disaster. The Columbia Accident Investigation Board is probing the cause of the shuttle's disintegration. Debris from the explosion of the space shuttle Challenger in 1986 is permanently sealed in a silo at Kennedy Space Center and there are no plans to release it for study. Web posted. (2003). [NASA to loan Columbia debris for study [Online]. Available WWW: <http://www.cnn.com/> [2003, April 14].]

◆ Almost two years before the Columbia disaster, NASA inspectors discovered a serious weakening of a shuttle's protective left-wing panel and ordered a fleet-wide inspection out of fear the problem would turn up in other shuttles, internal space agency documents show. Inspectors were ordered to feel for similar cracks on wing panels of other shuttles. They found none, but NASA now acknowledges its testing might have missed deterioration on shuttles like Columbia because of difficulties detecting such flaws without removing wing panels and cutting them apart. "There is no technology right now to do effective, nondestructive testing," NASA Administrator Sean O'Keefe said in an interview with The Associated Press. "It's a conundrum, one we really have to get better at and have to really figure out." NASA knew that visual inspections of wing panels were inadequate. An engineering study a year before the fleet inspection concluded that underlying damage to wing panels "can extend significantly beyond" anything seen on the outside. One of the study's authors, Ignacio Norman, later participated in intense debates within NASA during Columbia's mission about whether it might return safely. Columbia was NASA's oldest shuttle when it disintegrated above the earth Feb. 1, killing the crew. Investigators have focused on its left wing and the type of protective panels cited in the earlier safety review. Documents reviewed by the AP showed that when the shuttle Discovery returned from space after its March 2001 mission, inspectors were alarmed to discover a 2-inch tear caused by corrosion on a left wing heat-resistant panel. They called the flaw "serious." Inspectors had looked at the same panels three hours before liftoff and found no such damage. The damage was among the most significant following space missions in recent years, because damage to a wing's leading edge is considerably more likely to doom a shuttle than anywhere else. NASA requires immediate repairs when damage to the protective panels exceeds four-hundredths of one inch, about the thickness of a dime. At the time, inspectors said Discovery's safety was not jeopardized. They concluded the damage was caused by small amounts of oxygen slowly penetrating the U-shaped panel's surface and weakening its outer coating of silicon carbide, a brittle material. The coating protects the leading edge of a shuttle's wings from temperatures that can climb to nearly 3,000 degrees during re-entry. The engineers feared similar corrosion damage to wing panels on other shuttles, especially older ones. They speculated this corrosion appeared on Discovery because it had just returned from its 29th flight, a record number at the time. Columbia was on its 28th mission when it was destroyed. It was a dramatic illustration of recurring corrosion problem that has frustrated NASA for years. In recent weeks, it has increasingly captured the attention of the board investigating the Columbia accident. NASA has said it closely studied the corrosion problem from 1995 to 1997. It ordered more inspections, began recoating panels after every 16 flights and placed new restrictions on how many flights each panel could make. None of the panels aboard Columbia had exceeded those limits. Damage to Discovery was so worrisome that NASA additionally ordered inspectors to begin feeling for cracks along wing panels before every shuttle mission. Months before Columbia's breakup, it also began testing a new technique, thermography, to scan for cracks inside panels - with mixed results so far. Harold Gehman Jr., a retired Navy admiral heading the investigation, has indicated the board soon will recommend that NASA improve testing to find flaws on older shuttles. Safety inspectors routinely swarm over returning shuttles, looking for cracked insulating tiles or other damage. "This is now and has always been very serious," Michael Kostelnik, NASA's deputy associate administrator for the shuttle, told the AP. Web posted. (2003). [NASA found weakened wing panel on another shuttle two years before Columbia accident [Online]. Available WWW: <http://www.floridatoday.com/> [2003, April 14].]

◆ Engineers have uncovered a potential problem with the two identical Mars Exploration Rovers that will be launched to the Red Planet in the coming months, prompting NASA to delay liftoff of the first rover by one week "The concern regards cabling that connects the spacecraft's main computer, which is inside the rover, to peripherals in the cruise stage, lander and small deep space transponder. The connection to the cruise stage is severed during approach to Mars and the connection to the lander is severed before the rover drives off," NASA said in a statement Monday. "Pre-launch testing revealed a potential problem in how the spacecraft interprets signals sent when the cables are severed. The problem will require fixing on both rovers." The repair will require some disassembly of the spacecraft, which are located at Kennedy Space Center. The extra work cannot be completed within the schedule of preparations for the original May 30 launch date for the first rover, forcing a postponement to no sooner than June 6 at 2:12:44 p.m. EDT. The mission will have two launch opportunities each day during the planetary alignment window, which is scheduled to close on June 19. Arrival at Mars is set for January 4, 2004, regardless of launch date within that period. Repairs are not expected to affect the planned 12:38:16 a.m. EDT liftoff June 25 of the second rover. That launch period extends through July 15, setting up a landing on January 25, 2004. Both rovers will fly atop Boeing Delta 2 rockets launched from Complex 17 at Cape Canaveral Air Force Station, Florida. Ten days will be needed between launches. Web posted. (2003). [Fix ordered for possible problem on twin Mars rovers [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, April 14].]

April 15: A long, narrow slit on Columbia's left wing may have let in scorching heat and doomed the space shuttle during its plunge through the atmosphere, accident investigators said Tuesday. Such a gap could have been caused by a missing or broken seal on the leading edge of the wing, and is the latest – and now strongest – suspect in the 2 ½ month old inquiry. The seal is close to where the investigators believe a chunk of foam insulation hit during liftoff, and the impact could have broken or weakened the seal and all or part of it floated away from Columbia during its second day in orbit. "It's possible we may not be dealing with a round hole but instead something that created a long, narrow slit," said Scott Hubbard, a high-ranking NASA official on the Columbia Accident Investigation Board. The board previously suspected that a mysterious object seen floating away from the shuttle was another part of the wing. But additional testing and the growing debris collection have ruled out a so-called carrier panel, and the only remaining possibilities are a seal or a fragment of a reinforced carbon-fiber panel, said Navy Rear Adm. Stephen Turcotte, a board member. The U-shaped carbon-fiber seals are located between each carbon panel and wrapped around the leading edge of each shuttle wing. These custom-fitted seals, like the carbon panels, are bolted onto the wing and subject to wear and tear. If even just one bolt was damaged by the foam that broke off Columbia's fuel tank barely a minute after liftoff, the seal or a chunk of it could have come loose the following day, the board said. Web posted. (2003). [Investigators say slit wing may have doomed shuttle [Online]. Available WWW: <http://www.cnn.com/> [2003, April 15].]

◆ As the central Texas search for material from the Space Shuttle Columbia moved westward, the East Texas search began nearing completion. Air operations continued last week, and underwater searches were completed. Search teams have completed 98 percent of the underwater searches in Lake Nacogdoches and Toledo Bend Reservoir. Ground teams have completed 78 percent of their primary search area, and airborne crews finished 80 percent of their assigned area. More than 70,000 items, weighing 78,000 pounds, about 36 percent of the Shuttle by weight, have been delivered to Kennedy Space Center for use in the mishap investigation. Officials are finalizing plans to create a Columbia Recovery Office (CRO) at Johnson Space Center, Houston. The CRO will assume responsibility for management of recovery and community liaison activities. The Disaster Field Office in Lufkin, Texas, the central planning and command center for the search, is expected to close in early May. NASA and FEMA are working with partner agencies to close the four Incident Command Posts and the Mobilization and Staging Area. The U.S. and Texas Forest Services managed the Incident Command Posts, and they are expected to close the first of the camps in late April. Camps are located in Hemphill, Nacogdoches, Palestine and Corsicana, Texas. The painstaking search of the main 2400 square mile search corridor was executed through the combined efforts of NASA, FEMA, EPA, U.S. and Texas Forest Services. Individuals from these organizations, aided by local authorities and landowners, have worked long hours under arduous conditions over difficult terrain to recover Shuttle debris. Web posted. (2003). [East Texas recovery search nears completion [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, April 15].]

April 17: NASA expects no immediate cuts in its contractor work force while its shuttle fleet is idled during the search for the cause of the Columbia accident, the space agency administrator said on Thursday. "For the near term, there doesn't appear to be any dramatic change" in employment, NASA Administrator Sean O'Keefe told the National Press Club. He said the shuttles were grounded for repairs for five months last year after a hairline fracture was discovered in one of the orbiters' fuel lines, and there was no significant impact on the contractor work force while repairs were made. "It didn't stop the world," O'Keefe said. It was too early to know if additional workers would be needed to make upgrades on the three remaining shuttles once the cause of the Columbia accident is known, he said. Web posted. (2003). [NASA chief sees no cuts in shuttle work force [Online]. Available WWW: <http://biz.yahoo.com/> [2003, April 17].]

◆ NASA should improve its shuttle inspections before the space agency returns the remaining three orbiters to flight, the Columbia Accident Investigation Board recommended Thursday. In addition, it said NASA should make it standard procedure to obtain spy-satellite photographs of shuttles while in orbit. "We have a procedure now to make imagery and national assets available to us," NASA Administrator Sean O'Keefe said Thursday in a speech at the National Press Club in Washington. The independent panel of experts found NASA's current inspection techniques are not good enough to detect internal damage or flaws in special composite panels that protect the leading edge of each space shuttle wing. Previously, the investigation panel concluded a breach on or near one of the panels allowed superheated air to burn through Columbia's left wing and destroy the vehicle as it sped back to Earth after a two-week mission. What caused the breach is not yet known. A leading theory is a chunk of insulating foam the size of a small suitcase broke off the huge external fuel tank 80 seconds after launch and struck the leading edge of Columbia's left wing. NASA officials already have assigned a team of engineers to begin working on the panel inspection process, said Michael Greenfield, associate deputy administrator for technical programs. Currently, inspectors visually check each wing panel before and after each shuttle flight. They also touch and tap each panel to check for looseness, Greenfield said. The accident investigation board, chaired by retired admiral Harold W. Gehman Jr., concluded those inspections were not adequate. Board members urged the National Aerospace and Safety Administration to craft a new inspection plan that would use technology -- such as ultrasound and x-ray devices -- already widely used in military and commercial aviation. Greenfield said NASA will most likely adopt one or both of those techniques after certifying they would work on the special composite materials used on the shuttle panels. "We can get that done within a reasonable time, certainly months," said Greenfield, who is co-chairman of the agency's return-to-flight working group. The investigation panel also recommended NASA make it standard procedure to obtain spy-satellite photographs of shuttles while they are in orbit. NASA officials have already acted to make that happen. Last month, O'Keefe reached an agreement with the National Imagery Mapping Agency to use the agency's classified spy satellites to routinely photograph future shuttles in orbit. The agreement resulted from the discovery that, while Columbia was still in orbit, NASA did not pursue recommendations from its engineers that the agency obtain high-resolution images of the shuttle to help assess any damage caused by the foam debris on launch. The board's two recommendations are the first of many it is expected to make as it moves toward a final report on hardware, procedures and judgment calls that contributed to the Columbia disaster. One key area to be addressed is what to do about foam insulation and other debris that has repeatedly broken off and struck the orbiter vehicles. Greenfield said a NASA team is drafting solutions and will be ready to respond when the board issues its recommendations. ["Panel urges closer wing checks," **Florida Today**, April 18, 2003, p 1A & 2A.]

April 18: NASA managers have decided to postpone the launch of SIRTf (Space Infrared Telescope Facility) aboard a Boeing Delta II rocket until no earlier than mid-August 2003. The delay will allow engineers enough time to change out one of the nine solid rocket motors attached to the Delta II rocket, which had multiple delaminations within the layers of material that comprise the engine-nozzle exit-cone liner. "There simply is not enough time to remove and replace the rocket motor to support a SIRTf launch in advance of the Mars Exploration Rover-B launch window," said Karen Poniatowski, Assistant Associate Administrator for Launch Services at NASA Headquarters, Washington. The upcoming launch dates of the Mars Exploration Rovers (MER A and B), also on Delta II rockets, are June 6 and June 25, respectively. The MER-A mission, originally scheduled for May 30, was recently rescheduled to June 6 due to a potential problem with cabling on the spacecraft. The launch of the Galaxy Evolution Explorer

mission, or GALEX, is on schedule for launch on a Pegasus rocket on April 28. ["NASA Delays SIRT Launch," **NASA News Release #03-145**, April 18, 2003.]

◆ Ron Dittmore is expected to announce his resignation as NASA's space-shuttle program manager next week, agency sources told the *Orlando Sentinel* on Friday. It is unclear when Dittmore's resignation will become effective. Sources at the National Aeronautics and Space Administration said the search for successor is under way. Dittmore is quitting NASA for a job in industry, the sources said, and already was planning to leave the agency when the final Columbia mission was launched on Jan. 16. ["Dittmore to resign as shuttle manager," **Orlando Sentinel**, April 19, 2003, p A1 & A6.]

April 19: NASA is considering major changes to future shuttle mission that range from launching only in daylight to inspecting and possibly repairing the orbiter while in space. Conceived in response to the Columbia accident, most of the proposals are designed to better detect damage from debris strikes to the shuttle during launch and try to fix them. But gains in those areas could mean trade-offs in mission capabilities as well as new costs. Staging a spacewalk to inspect or repair the orbiter could mean postponing planned excursions to do work on the international space station. Any new restrictions to the shuttle's launch rules would create new potential for delays. And the cost of implementing the changes would fall on an agency already struggling to make ends meet. Even so, aerospace experts say changes of this sort are necessary and inevitable as the National Aeronautics and Space Administration moves to protect future crews in the aftermath of Columbia's breakup over Texas on Feb. 1. ["Shuttle changes may spur delays, up costs," **Orlando Sentinel**, April 20, 2003, p A1 & A18.]

April 20: Investigators probing the Columbia disaster are developing an increasingly detailed scenario that explains the sequence of events that led to Columbia's destruction, a scenario that matches up with telemetry and recorded data as well as the damage seen in recovered debris. Only two out of 10 initial scenarios are still being actively developed by NASA investigators, officials say, but one of them, which assumes a breach in the left wing at or near leading edge panel No. 8, has emerged as the leading contender. This scenario, No. 2 on the original list of 10 being assessed by agency managers and engineers, matches the telemetry downlinked from the shuttle before its breakup as well as data recorded on board by Columbia's payload experiment support recorder, or OEX, which was recovered near Hemphill, Texas, March 19. It also explains unusual communications dropouts and unexplained flashes seen in the wake of the shuttle as it descended across the southwest United States. The scenario matches up well with the known point of impact where foam debris from Columbia's external fuel tank slammed into the left wing at 450 mph just 82 seconds after liftoff. In fact, OEX data from thermocouple V07T9895, located on the left wing spar just aft of reinforced carbon carbon panel No. 9, shows a slight temperature increase after the strike that may be indicative - this is not yet confirmed - of leading edge damage. OEX data recorded during re-entry also is consistent with the severe heat damage seen in recovered debris, which strongly suggests a breach at or very near the underside of RCC panel 8, one of 22 such carbon composite panels making up the leading edge of the left wing. The U-shaped panels, held in place by so-called T-seals that are bolted to the front face of the wing spar with inconel fittings, are designed to protect the wing from 3,000-degree re-entry temperatures and to handle aerodynamic loads as the shuttle falls into the thickening atmosphere. "Independent teams examining the recovered debris are finding that the most likely location of (the) initial breach into the vehicle was into the left hand wing RCC panel 8/9 area," according to a summary of the scenario. Scott Hubbard, a member of the Columbia Accident Investigation Board, said much the same thing during a news conference last Tuesday. The only other scenario still under active consideration by NASA engineers involves a breach in RCC panels closer to the shuttle's fuselage. But it does not fit the facts as closely as scenario No. 2. Web posted. (2003). [NASA scenario for loss of Columbia and crew refined [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, April 20].]

April 22: The Columbia Orbiter Memorial Act, born in the legislation introduced in March in the Senate by Ted Stevens (R-Alaska), and in the House of Representatives by C.W. Bill Young (R-Fla.), was signed into law by the President last Wednesday. NASA Administrator Sean O'Keefe said, "The actions by the Congress and the President to honor the crew of the Space Shuttle Columbia is heartfelt by the entire NASA family and by the entire country. A national memorial in the Nation's capital will serve as a reminder about what the crew of Columbia stood for, bravery, honor, and the quest for knowledge. I feel it

will help inspire future explorers and help keep the spirit of exploration alive in America. We at NASA are grateful for the support from Senator Stevens and Congressman Young for the timely and thoughtful legislation and their caring approach to commemorate the Columbia crew." President George W. Bush signed the "Emergency Wartime Supplemental Appropriations Act, 2003" into law on April 16, 2003. The "Columbia Orbiter Memorial Act" is contained in what is now Public Law Number 108-11. The memorial will be placed in the Arlington National Cemetery near the memorial to the crew of the Space Shuttle Challenger. The law authorizes the Secretary of the Army, in consultation the NASA, to place the Columbia marker in Arlington National Cemetery, and authorizes up to \$500,000 of previously appropriated funds for the memorial. The legislation also authorizes NASA to collect gifts and donations, over the next five years, for the Columbia Memorial. It also permits NASA to erect other appropriate memorials or monuments with private donations. The law allows NASA to transfer collected money or property for the fund to the Secretary of the Army to defray expenses. Memorial fund procedures will be established and announced in the near future. The Space Shuttle Columbia was lost on February 1, 2003 with her seven crewmembers, astronauts Rick Husband, Willie McCool, Mike Anderson, David Brown, Kalpana Chawla, Laurel Clark, and Ilan Ramon. The Columbia crew's marker will join the memorial to Challenger crew, Ronald McNair, Ellison Onizuka, Judith Resnick, Dick Scobee, Michael Smith, Gregory Jarvis, and Christa McAuliffe, lost on January 28, 1986. ["Space Shuttle Columbia Memorial Approved For Arlington," **NASA News Release #03-147**, April 22, 2003.]

◆ The chairman of the board investigating the breakup of the shuttle Columbia said today that the panel was moving into a new phase and planned to develop a working hypothesis for the accident and refine it to fit the available evidence. After weeks of insisting that nearly nothing has been ruled out, board members are now clearly focused on foam from the shuttle's external tank that struck and apparently damaged the leading edge of one wing on launching. A piece of the leading edge floated away on the second day in flight, and on re-entry hot gas entered the wing and destroyed the orbiter. After 11 weeks of investigation, a milestone will come on Thursday (April 24), said Adm. Harold W. Gehman, who is chairman of the inquiry board, when his group meets with NASA officials to share theories about the chain of events that destroyed the shuttle. They will also begin the arduous process of ironing out what additional analysis is needed to establish a picture of what happened in as much detail as possible. Web posted. (2003). [New Direction for Shuttle Inquiry [Online]. Available WWW: <http://www.nytimes.com/> [2003, April 22].]

◆ Nothing could have been done differently to save shuttle Columbia and its crew during the ship's ill-fated return to Earth, a NASA study has concluded. In an internal April 22 report from the flight director office at Johnson Space Center, a team looked at whether possible changes to Columbia's re-entry -- including jettisoning tons of equipment and supplies -- might have significantly lowered deadly heating on the orbiter. Besides analyzing the potential effects of reducing the shuttle's weight before landing, the study also considered whether chilling down portions of the orbiter's left wing might have enabled it to fly longer. The conclusion: neither would have made a difference if Columbia already had suffered serious damage to its protective heat armor on the left wing's leading edge. Investigators suspect a 2-pound piece of foam insulation from Columbia's external fuel tank broke off and struck the leading edge 82 seconds after liftoff on Jan. 16. The impact likely caused a breach in Columbia's thermal-protection system. That breach allowed 3,000-degree gases to eat away at the left wing as the orbiter re-entered Earth's atmosphere on Feb. 1, eventually causing the ship to break up 38 miles above central Texas. Managers at the National Aeronautics and Space Administration have come under fire in recent weeks for not asking a U.S. intelligence agency to photograph possible damage to Columbia in orbit with top-secret telescopes or spy satellites. Even if the images had been taken, shuttle officials say, it's unlikely the pictures would have been definitive enough to warrant taking some of the radical -- and likely futile -- measures discussed since the accident. "I can't imagine anyone being sure enough to make a decision that would do some of these things or throw away a multibillion-dollar piece of hardware," a veteran NASA manager said. "You would have to know beyond the shadow of a doubt that you couldn't make it back to the runway -- and we didn't." In addition to the April 22 report's findings, shuttle engineers long have maintained it would have been impossible to launch a rescue mission aboard another shuttle or have Columbia's astronauts seek safe haven at the international space station. ["Shuttle crew was doomed," **Orlando Sentinel**, May 1, 2003, p A1 & A14.]

April 23: Ronald D. Dittemore, a 26-year NASA veteran, today announced his intention to step aside as the Space Shuttle Program Manager at the Johnson Space Center in Houston to pursue other opportunities. Dittemore, who has served as the Shuttle program manager for more than four years, will remain in his current position until the Columbia Accident Investigation Board finishes its investigation and a complete "Return to Flight" path has been established. "My decision to leave the Space Shuttle Program has been a very difficult one, but it is a decision that I began struggling with long before the tragedy of the Columbia accident," Dittemore said. "The timing of my departure is based on what I believe will allow for the smoothest management transition possible, as the pace of work to return the Shuttle to flight begins to ramp up." Dittemore made the announcement in Washington with Michael Kostelnik, Deputy Associate Administrator for the Space Shuttle and International Space Station Programs. Kostelnik praised Dittemore's dedication and professionalism. "For more than a quarter-century, Ron has been an integral part of the Space Shuttle program. He helped create many of the processes and procedures we follow today," added Kostelnik. "I'm pleased Ron has decided to stay until our Return to Flight efforts are well established, and I wish him the best as he begins a new chapter in his life." ["Space Shuttle Program Manager Decides To Leave Post," **NASA News Release #03-149**, April 23, 2003.]

◆ On April 23, 2003, Michael T. Pankiewicz of Port Orange, Florida, was indicted for theft of government property, transporting stolen goods across state lines, and making false statements. Pankiewicz allegedly stole space shuttle Columbia debris while in Texas working on the recovery effort. Pankiewicz, a NASA employee at the Kennedy Space Center, assisted in recovering space shuttle Columbia debris in East Texas. Pankiewicz is alleged to have removed shuttle debris without NASA's permission and transported the debris to the Middle District of Florida. In addition, Pankiewicz allegedly made false statements to federal agents in connection with the case. ["NASA Employee Indicted For Theft of Shuttle Debris," **NASA News Release #2003-034**, April 25, 2003.]

April 24: The NASA Accident Investigation Team today presented results of the agency's on-going analysis of the Columbia disaster to the independent board charged with finding the root cause of the disaster. That presentation is believed to have included one or more possible "best-fit" scenarios based on telemetry, recorded data and debris recovered to date. One such scenario, which assumes a breach in Columbia's left wing at or near leading edge panel No. 8, was outlined here last weekend. Major elements of that scenario presumably were briefed to the CAIB today. Ten members of the board were either present for the briefing or listening in via telephone. Between 30 and 40 NASA and contractor personnel participated. But in a short news release, the board said "in order to finalize a primary working scenario, more work is required in four areas of analysis. "Those four areas are: aerothermal analysis, foam impact testing, testing of flown reinforced carbon carbon panels, and metallurgical analysis from debris," the statement said. "The NAIT provided an overview of the latest data recorder information and the CAIB issued its guidance based on that data and board investigators' continuing analysis of the latest orbiter debris." The release concluded that "the CAIB has not reached any final conclusions and has not determined the cause of the loss of the shuttle and crew." A source close to the board said CAIB investigators were in "violent agreement" on the basics of the accident scenario, i.e., a breach in the left wing near RCC panels 8 and 9 led to the disaster. But there is not yet agreement on the finer details of how the plume of super-heated air entering the breach propagated through the wing and ultimately led to its failure. Web posted. (2003). [NASA, CAIB investigators compare notes on disaster [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, April 24].]

◆ A quality-assurance worker at Kennedy Space Center, accused of taking pieces of shuttle Columbia debris, pleaded not guilty in federal court in Orlando on Thursday. Bail was set at \$25,000. Michael Pankiewicz, of Scottsboro was part of a group of KSC workers sent to Texas in the first days of the search for Columbia debris. About March 28, he tried to take one or more pieces of the shuttle from Texas to Brevard County, according to the indictment. Pankiewicz was arrested late Wednesday (April 23) by federal officers and charged with stealing government property, transporting stolen government property and lying to federal law enforcement investigators, said Carolyn Adams, a spokeswoman for the U.S. Attorney's Office in Orlando. "NASA is looking at actions that are appropriate," said KSC spokesman Bruce Buckingham. ["NASA worker denies taking shuttle pieces," **Florida Today**, April 25, 2003, p 11A.]

April 25: A Soyuz rocket carrying an American and a Russian soared into the clouds over Kazakhstan early today. It was the start of a mission to keep the International Space Station alive until the U.S. shuttles fly again. The Russian rocket lifted off about 9:54 a.m. Kazakhstan time, or 11:54 p.m. EDT Friday, and reached orbit more than eight minutes later. "For the U.S. program, it's extremely important, because it maintains not just human presence, but American human presence in space, on the International Space Station," NASA chief astronaut Kent Rominger said at Baikonur, in Central Asia. He praised the partnership with Russia. Docking is planned for 1:56 a.m. EDT Monday (April 28). ["Pair soars into orbit," **Florida Today**, April 26, 2003, p 1A & 3A.]

◆ NASA has asked Apollo-era astronaut Tom Stafford to lead an independent group that will oversee how the agency carries out recommendations from the board investigating the shuttle Columbia tragedy. NASA Administrator Sean O'Keefe confirmed Friday that he has talked with Stafford about the post, but added that several others also are under consideration. O'Keefe said he wants a team looking over NASA's shoulder to "keep us honest" as the agency eventually works through suggested safety improvements. The recommendations are expected sometime this summer in a final report issued by the Columbia Accident Investigation Board, led by retired Navy Adm. Harold Gehman Jr. Seven astronauts were killed Feb. 1 when the ship disintegrated during its slide back through the atmosphere at the end of a 16-day science mission. The board's recommendations could address everything from the aging of the shuttle fleet to problems in NASA's organizational structure. "I've been talking to him [Stafford] about ideas he has about how we can establish a backstop and a back check on what we're doing here to implement, because the Gehman board has made it quite clear that they don't intend to be the enforcers," O'Keefe said. "Once they've finished their report, they intend to go back to their lives." A similar oversight group was created after the 1986 Challenger accident. At that time, the National Research Council formed a scientific panel to monitor NASA's compliance with recommendations from the Rogers Commission, which investigated the agency's first shuttle fatality. In Columbia's case, investigators suspect the shuttle broke up while returning to Earth after incurring damage from debris during launch. A large chunk of foam broke off the external tank about 80 seconds after liftoff and slammed into the edge of the wing, possibly creating a breach that allowed hot gases to seep inside as it re-entered the atmosphere. O'Keefe said he is looking to Stafford, 72, because of his many years of experience in spaceflight, and most recently, his work leading a task force that examined the safety of reducing the crew of the international space station from three people to two. ["NASA to add safety enforcer," **Orlando Sentinel**, April 26, 2003, p A1 & A23.]

April 28: NASA's Galaxy Evolution Explorer spacecraft was successfully launched today from a Pegasus XL rocket released by an L-1011 aircraft off the coast of Florida's Cape Canaveral Air Station at 7:59:57 a.m. Eastern Daylight Time (4:59:57 a.m. Pacific Daylight Time). The mission features an orbiting telescope that will observe millions of galaxies across 10-billion years of cosmic history. Its findings may help astronomers determine when the chemical elements originated and the stars we see today first blossomed. After the space observatory separated from the rocket's third stage - at 11 minutes and 5 seconds after release from the L-1011 carrier aircraft -- it entered into Earth orbit at an altitude of 690 kilometers (429 miles). The spacecraft's signal was acquired at about 8:21 a.m. Eastern Daylight Time (5:21 Pacific Daylight Time) by the Tracking and Data Relay Satellite System. At 8:45 a.m. Eastern Daylight Time (5:45 a.m. Pacific Daylight Time), the satellite deployed its solar arrays and locked on to the Sun. A tracking station near Perth, Australia then acquired the spacecraft's signal at 8:54 a.m. Eastern Daylight Time (5:54 a.m. Pacific Daylight Time). After one month of in-orbit checkout, the science mission will begin. It will last for up to 28 months. ["GALAXY Evolution Explorer On Its Way," **KSC News Release #33-03**, April 28, 2003.]

◆ Investigators have found pieces of a key seal from the leading edge of Columbia's left wing that could revise an emerging theory on what caused the orbiter to break up during re-entry. Two parts of a T-shaped seal thought to have filled the gap between a pair of critical reinforced carbon-carbon, or RCC, panels were identified last week, according to NASA documents. The find is significant because it could narrow the possible causes of a breach in Columbia's protective heat armor that led to the ship's disintegration as it headed toward a Feb. 1 landing at Kennedy Space Center. The RCC panels, numbered 8 and 9, are among 22 U-shaped thermal shields that guard the left wing's leading edge from temperatures of up to 3,000 degrees during the shuttle's fiery plunge home through Earth's atmosphere. The seal is a T-shaped rib of reinforced carbon-carbon that is custom fitted to protect the seam between the panels. The seal and RCC

panels in question are located in the same general area about midway down the leading edge where a 2-pound piece of foam insulation from Columbia's external fuel tank hit the orbiter 82 seconds after launch Jan. 16. Investigators suspect the strike created a breach that allowed blowtorch-like hot gases to destroy the wing, gradually causing the ship to break up 38 miles above Texas. ["Recovery of key shuttle seal could refocus investigation," **Orlando Sentinel**, April 29, 2003, p A13.]

April 29: Columbia accident investigators will recommend NASA painstakingly check and clear all shuttle systems to make sure they played no role in the Feb. 1 disaster. They want NASA to finish before returning the remaining orbiters to flight. Nearly three months after the shuttle catastrophe, just two shuttle systems – those involved with astronaut crew training and Columbia's cargo bay module – have been absolved of any role in the accident. A third, the twin solid rocket boosters, likely will be cleared in the coming weeks. But the completion of fault-tree analyses of other systems could come after the Columbia Accident Investigation Board issues its final report in mid-July. The myriad other systems include the space shuttle's main engines, orbital maneuvering system, heat-protection system, external fuel tank and life-support systems. The chairman of the board said on Tuesday the panel is preparing to recommend NASA finish all that work before launching another shuttle. ["Board tells NASA to check all systems," **Florida Today**, April 30, 2003, p 3A.]

◆ A critical phase in the Columbia accident investigation begins this week when engineers start shooting chunks of foam at the tiles that protect NASA's space shuttles from the heat of re-entry. These first tests – aimed at the silica tiles that blanket the ships' bellies – will help engineers calibrate instruments and prepare for the more significant work to follow in June, when foam will be fired at the panels that cover the edges of the wings. Investigators said Tuesday that they will attempt to recreate the foam impact that Columbia suffered during launch, when a 2-pound chunk of insulation fell off the external tank and slammed into the edge of the left wing. The work, conducted at the Southwest Research Institute in San Antonio, will help investigators focus as they sift through the "mountain of data and debris" collected so far. But even so, the chairman of the Columbia Accident Investigation Board warned that the foam shots will not provide absolute answers. It can't prove that the foam fatally damaged the shuttle, only that it's a possibility, said retired Navy Adm. Harold Gehman Jr. The testing could start as early as Thursday. ["NASA eager for foam tests," **Orlando Sentinel**, April 30, 2003, p A8.]

April 30: While many things tragically were lost in the shuttle Columbia accident, there have been some unlikely survivors. Searchers in the debris field in Texas recently recovered a canister that flew aboard the shuttle carrying a set of live moss and roundworms, *C. elegans* to be precise. After its recovery, the 9-pound research canister was taken to Hangar L at Cape Canaveral Air Force Station, where NASA life scientists work. There, they opened it on Monday and found hundreds, if not thousands, of the worms, each about the size of a tip of pencil lead. The tiny worms had been multiplying since the shuttle broke up over the western United States. Scientists estimated they were in their fourth or fifth generation, since each worm only lives about seven days. The worm experiment was designed to study a new synthetic nutrient for the worms. It was designed by researchers at Ohio State University and NASA's Ames Research Center in California. "We don't know what kind of science can be derived from that, if any," NASA spokesman Bruce Buckingham said. The experiment had called for the worms to be taken off the shuttle in the hours following landing. "To my knowledge, these are the only live experiments that have been recovered," Buckingham said. In that same locker, scientists found some *Ceratodon* moss that had grown in a spiral pattern on Columbia. The recovery effort in Nacogdoches, Tex., concluded Wednesday. Other sites in Texas and Louisiana will be closing down shortly. "By May 6, we'll be completely through in Texas," said Mike Leinbach, who is leading the reconstruction of Columbia. ["Searchers find live research worms," **Florida Today**, May 1, 2003, p 1A.]

◆ The last truck carrying shuttle debris from Barksdale Air Force Base in Louisiana to Kennedy Space Center will arrive next Tuesday. Any parts that people report to NASA will be hand-delivered or sent express delivery. In all, more than 82,000 pieces of the orbiter have been recovered. That's 84,800 pounds, more than 38 percent of the orbiter's weight. In the hangar where engineers are reconstructing the orbiter, two new tools have appeared alongside the pieces from the front edge of the left wing, the area where some sort of breach or hole occurred that allowed superheated gas to seep inside the shuttle's wing. One is a set of four charts mapping out a three-dimensional image of debris from the left wing. It shows where each piece

they have recovered fits, potentially making it easier to see patterns. Workers are drawing up similar diagrams for the right wing to compare the two. The other tool amounts to a giant plexi-glass mold of the curved front part of the left wing. In it, engineers are placing the Reinforced Carbon-Carbon panels that survived the crash. By putting together this jigsaw puzzle, they hope to see patterns from the metal that melted and later solidified on the RCC structure. It may also be significant to see what is missing. "Where the breach occurred -- I believe we'll get there," said Mike Leinbach, who is leading the reconstruction of Columbia. ["Two new tools help in Columbia reconstruction," **Florida Today**, May 1, 2003, p3A.]



Retired Navy Admiral Harold W. Gehman Jr. (third from left), chairman of the Columbia Accident Investigation Board, visits the Thermal Protection System shop and is briefed by Martin Wilson (second from left), the shop manager. Gehman and other members of the board are visiting sites at KSC to become familiar with the Shuttle launch process. The independent board is charged with determining what caused the destruction of the Space Shuttle Columbia and the loss of its seven-member crew on Feb. 1 during reentry.

Pictured: Martin Wilson (second from left); Retired Navy Admiral Harold W. Gehman, Jr. (third from left); Steven B. Wallace (next to Gehman); Air Force Major General John L. Barry (next to Wallace); G. Scott Hubbard (next to Barry).

MAY

May 1: Answering pointed questions from senators, NASA Administrator Sean O'Keefe said Thursday that while the shuttle's won't fly again until the agency is certain they are safe, he also won't steal from other projects to pick up the tab. "I assure you our intent is not to rob other programs in order to pay for shuttle costs," O'Keefe said. "That is not in the mix." Testifying before the Senate Appropriations subcommittee that oversees the National Aeronautics and Space Administration's budget, O'Keefe told lawmakers it's simply too soon to start talking about how much it will cost to fix the shuttles and get them back into orbit. NASA's budget request for the 2004 fiscal year, which will begin Oct. 1, was prepared before the Feb. 1 Columbia accident, which grounded the fleet and threw the entire U.S. manned spaceflight program into chaos. Until the investigation board issues its recommendations – and NASA figures out what it will cost to fly the shuttle again – O'Keefe seems determined not to ask for more money. After the hearing, he said he doesn't even know yet how much money would be too much to spend on returning the shuttles to orbit. "It going to be what it's going to be. Whatever the recommendations take to implement, that what we're going to take a look at, and that's what we'll vet through the administration for the purpose of determining exactly what we'll do," O'Keefe said. ["Columbia accident snarls NASA budget," **Orlando Sentinel**, May 2, 2003, p A20.]

◆ NASA's remaining three shuttles won't return to flight this year as the agency had optimistically planned, members of Congress said Thursday. That means NASA likely will have to rely again in February on a Russian Soyuz spacecraft to take another fresh crew to the International Space Station. After meeting privately for an hour with retired Adm. Hal Gehman, chairman of the Columbia Accident Investigation Board, two senior House lawmakers emerged to predict NASA's shuttles would remain grounded for some time given the scope of work the independent panel is likely to recommend this summer. "Any kind of hope of being in flight this year is just overly optimistic," said Rep. Bart Gordon, D-Tenn., a senior Democrat on the House Science Committee. That committee is closely tracking the accident board's work. "We'll have to rely on the Russians one more time," Gordon said. Rep. Sherwood Boehlert, R-N.Y., who is chairman of the Science Committee, agreed. "I have the distinct impression the ambitious schedule forecast for return to flight for October is just that, very ambitious," said Boehlert whose Capitol Hill office served as the backdrop for the meeting with Gehman. "I don't think that is a realistic time frame." Earlier Thursday, NASA Administrator Sean O'Keefe told a Senate subcommittee that the space agency remained hopeful that the accident board's recommendations could be addressed in time for the shuttles to resume construction flights to the space station late this year. That now appears unlikely. Gehman briefed lawmakers on an exhaustive list of particulars accident investigators are compiling that will address hardware concerns on the shuttle vehicles as well as much broader concerns about management and human processes inside National Aeronautics and Space Administration processes, Gordon said. "We were all impressed he is going into a lot of contributing factors areas," Gordon said. "He's going to give us a lot of things to think about . . . in terms of personnel, budget, mindset and those sorts of things." Gehman declined to discuss with reporters the specifics of what he told lawmakers. He said he informed them the panel would try to have its final report ready by the end of July so lawmakers could review the document over the August recess. ["Launch unlikely this year," **Florida Today**, May 2, 2003, p 1A.]

◆ Shuttle Columbia was doomed before its ill-fated Feb. 1 atmospheric reentry, and it's unlikely a rescue mission could have been staged, an independent safety expert said Thursday. During its mission, NASA officials didn't think Columbia's left wing had been breached and that the shuttle crew would be lost. But even if the agency did know of trouble, it would have had to weigh whether it was prudent to rush shuttle Atlantis -- which was being readied for a planned March 1 launch -- into space to bring Columbia's astronauts home. "You're risking two crew members and one of your remaining vehicles," said Richard Blomberg, former chairman of the Aerospace Safety Advisory Panel, which was created by Congress in the wake of the 1967 Apollo 1 launch pad fire. "You probably have a lot of analogies with firefighters . . . At what point do you not reenter a burning building even though you know there are people in there?" Blomberg said he agrees with a recent NASA analysis that concluded that the crew could have done nothing prior to reentry to save the shuttle. Prepared at NASA's Johnson Space Center in Houston, the April 22 analysis was conducted to determine what might have been done to reduce heat and stress on the

shuttle's left wing during reentry. The analysis was led by a flight director on duty the morning of Columbia's reentry as planned. Columbia was launched Jan. 16, and its left wing was struck by a two-pound chunk of external tank foam insulation about 82 seconds into flight. Investigators since have determined that hot gasses penetrated the wing during atmospheric reentry, triggering the destruction of the ship. Among the possibilities examined for the April analysis were reducing the shuttle's mass or chilling its left wing before reentry. The best option, according to the analysis, would have been to jettison a cargo bay laboratory as well as food, water, clothing and non-essential equipment, reducing the shuttle's mass by about 15 tons. The effort would have required two or more spacewalks. Another option: "cold-soaking" the shuttle's left wing. The procedure would have called for the crew to maneuver the ship into a position where its left wing was shielded from the sun, effectively chilling it down before reentry. The analysis, however, concluded that none of the options would have prevented the accident. ["Analysis: Nothing would have saved crew," **Florida Today**, May 2, 2003, p 3A.]

◆ A light rain mixed with a few tears Thursday during a ceremony at Kennedy Space Center honoring the crew of shuttle Columbia. Spacehab officials unveiled a stone monument and bronze plaque bearing an artist's rendering of the seven astronauts who died Feb. 1. About 100 people gathered for the ceremony at Spacehab's Payload Processing Facility. "This site is a tribute to a gallant crew who touched greatness and made us proud," said Michael Kearney, the president and chief executive officer of Spacehab. Spacehab created a pressurized laboratory which first flew on Columbia's last mission. The lab allowed the crew members to perform more than 80 experiments during their 16 days in space. Kearney smiled as he recalled the playful nature of the astronauts, describing the somersaults of mission specialist Dave Brown and a "graceful swan dive" that payload specialist Ilan Ramon once performed while entering the lab in space. Astronaut Pam Melroy's voice cracked as she eulogized each of the crew, offering anecdotes about the men and women she considered friends. She described how her jaw dropped in surprise the first time she heard shuttle commander Rick Husband sing. "They were a very gentle, sweet group of people," Melroy said while standing in front of the monument. "We remember them." ["Company unveils honorary plaque," **Florida Today**, May 2, 2003, p1B.]

May 2: Columbia accident investigators are still trying to figure out why lower-level engineers were unable to route a request for spy-satellite photos of Columbia up the NASA chain of command. Meeting five days after Columbia's launch, a team of three dozen engineers determined NASA should request satellite photos to better gauge the amount of damage done to the shuttle's left wing. "They had real good engineering reasons for wanting the imagery," board member Sally Ride said. "Now the question is why didn't that request make it to the program managers and up into the system. And it's a little too early to characterize all the different places where that broke down. "But it's everything from just missed communication to areas in the system that might not have appreciated the importance of the imagery, might not have appreciated what information it could give them -- just a variety of different reasons." Diane Vaughan, a Boston College sociologist and NASA expert, said the situation was sadly ironic, given a high-profile NASA safety culture that encouraged "everyone to speak up at every opportunity." "The fact that the engineering request did not get fulfilled, indicates that there are some things that are acting to suppress information," she said. ["Panel can't decipher spy-satellite photo decision," **Florida Today**, May 3, 2003, p 6A.]

◆ Accident investigators suspect institutional breakdowns inside NASA contributed to the Feb. 1 Columbia disaster, and they likely will recommend sweeping changes to help prevent future space shuttle catastrophes. With the search for shuttle debris in Texas winding down and a technical cause all but determined, investigators have turned their attention to broader cultural and managerial failures they believe were factors in the shuttle's fatal atmospheric reentry. Three months of public hearings, news conferences and interviews with investigators show the board is considering recommendations that would call for NASA to:

- * Revamp a flawed problem-reporting system. A long history of shuttle damage from falling debris during launch was not well documented under the current system.
- * Analyze trends on hazards to the shuttle. Better trend analysis might have helped engineers spot potentially deadly problems with launch debris.
- * Strengthen independent oversight of engineering decisions about shuttle hazards and their risks. Independent oversight was lacking when a flawed analysis during Columbia's mission concluded a debris strike was not a flight safety issue.
- * Improve lines of communication so serious safety concerns among engineers reach senior decision-makers. The idea of obtaining spy satellite photos of

suspected wing damage while Columbia was in orbit was shot down by mid-level program managers. Investigators will not make such recommendations lightly. "We as a board are certainly skittish about making organizational changes to a very complex organization for fear of invoking the law of unintended consequences," said Harold W. Gehman, chairman of the Columbia Accident Investigation Board. Made up of civilian and military accident experts, the 13-member board continues to gather information and talk to people involved in the Columbia mission as well as independent experts on managing projects that involve risky technology. ["Board rips NASA failures," **Florida Today**, May 3, 2003, p 1A & 6A.]

May 3: Each shuttle launch that's suspended pending the outcome of the Columbia investigation means a loss of millions of dollars for the local tourism industry. The Space Coast Office of Tourism estimates that each shuttle launch typically generates \$4 million to \$5 million in visitor spending in Brevard County. So, with seven shuttle launches previously scheduled from March 2003 to February 2004 not likely to happen, that would be a loss of \$28 million to \$35 million for local hotels, restaurants, stores and attractions. And there will be more losses if NASA's remaining fleet of three shuttles doesn't go back into service after February 2004. Currently, NASA representatives say they don't know when the shuttles will return to flight. Space Coast Office of Tourism Executive Director Rob Varley estimates a typical shuttle launch draws 100,000 to 150,000 visitors to Brevard County. Many of them come from the Orlando area and stay less than a day. Although those visitors spend money while they're here, the ones who stay longer spend more, particularly on hotel rooms. Varley estimates each shuttle launch can result in an extra several thousand guests for area hotels. For sure, the Kennedy Space Center Visitor Complex, NASA's tourist attraction, has been hurt by the grounding of the shuttle fleet, but its business has been down this year more because of the decline in international travelers to Central Florida, Varley said. ["Shuttle grounding batters tourism," **Florida Today**, May 3, 2003, p 10A.]

◆ After shuttle Columbia disintegrated in flight Feb. 1, killing the seven astronauts on board, some assumed it was only a matter of time before the ax would fall on Kennedy Space Center's work force. The assumption was rooted in history, remembering the more than 2,200 workers who lost their jobs in the aftermath of the Challenger disaster in 1986. But NASA and its main shuttle contractor say this time is different, at least so far. The big difference is that NASA expects its remaining three shuttles to return to flight a lot sooner than was the case after the Challenger disaster, when the shuttle fleet was grounded for 2 1/2 years. Officials don't know when shuttle flights will resume, although they say it could be sometime next year. Now, three months after the Columbia disaster, the shuttle work force remains intact, but NASA officials say they don't know any more about what the future holds for the more than 6,000 local shuttle workers than they did before. Saturday's safe return of the Soyuz spacecraft to Kazakhstan after a trip carrying an astronaut and a cosmonaut to the International Space Station and bringing two other astronauts and a cosmonaut back means the NASA's space program averted further chaos. Of course, NASA representatives note, what ultimately happens with the shuttle fleet will depend on the outcome of the Columbia investigation, and any changes that follow. NASA also knows that any significant cutbacks in its shuttle work force would drain the area of relatively high-paying jobs and put people who have made careers in the space program out of work. "Nothing has changed," said NASA spokesman Bill Johnson at Kennedy Space Center. "If you ask that question next fall or next summer, there may be a different answer." ["Shuttle work force remains mostly intact," **Florida Today**, May 3, 2003, p 1A & 10A.]

May 5: An investment of almost \$8.7 billion might be needed between now and 2020 to keep NASA shuttles flying safely, an August 2002 agency report said. Those costs don't include money that might be required to make fleet repairs in the wake of the Feb. 1 Columbia accident, which killed seven astronauts. Released Monday, NASA's Space Shuttle Program 2020 Assessment shows that agency engineers estimate that it will cost almost \$4.4 billion in the next 17 years just to maintain the shuttle fleet and its attendant launch pads, control centers and other buildings. The report, which was prepared five months before the Columbia accident, also indicates the agency will need about \$1.47 billion for shuttle safety upgrades during the same time period. The upgrades and maintenance together would cost at least \$5.7 billion, but overruns could push the figure to \$8.7 billion. NASA already is seeing "the beginnings of erosion" in many areas within the 22-year-old shuttle program, the report said, including flight subsystems, ground facilities, special test equipment, vendor support and the work force. The investment is needed to maintain and improve safety if shuttles are to continue flying through 2020, the report said. During the 1990s, NASA had planned to retire the shuttle fleet in 2012. Those plans, however, were extended to 2020 after NASA

cancelled a billion-dollar effort to build a half-scale prototype of a shuttle replacement vehicle. ["Before tragedy, safety fixes estimated to cost \$8.7 billion," **Florida Today**, May 5, 2003, p 1A.]

May 6: Upon unscrewing a box at Kennedy Space Center, several scientists and teachers peered into their experiments from shuttle Columbia, and they found that several samples were amazingly intact. Five of nine experiments from the aluminum container that was found three months ago in the shuttle debris appear to be able to yield data, according to scientists who began opening containers holding shuttle experiments at the Kennedy Space Center. Scientifically, the most promising experiment of the nine was one developed by NASA investigator Dennis Morrison. The experiment manufactured capsules containing anti-cancer drugs that can be delivered directly to a tumor instead of the whole body. "It's pretty amazing that we've got samples at all," Morrison said Tuesday. Scientists need further examination before they know if the other experiments will yield data too. John Cassanto, president and CEO of Instrumentation Technology Associates, the company that made the hardware, said the experiments probably survived because of the way they were packed. The two aluminum boxes of the samples were in a little refrigerator in the Spacehab module, which was in the shuttle's cargo bay. Slightly longer than a cigar box, the hardware that survived the breakup of Columbia on Feb. 1 has a slightly charred smell to it. Its two knobs were burned off, exposing some copper wires. The box was made of aircraft-grade aluminum, and there is some evidence of melting inside, leading investigators to conclude temperatures reached more than 600 degrees Fahrenheit. The boxes were found around Nacogdoches, Texas, the day after the failed landing. ["Experiments survive Columbia tragedy," **Florida Today**, May 6, 2003, p 1B .]

◆ Independent accident investigators agree with NASA that foam debris likely punched a fatal hole in shuttle Columbia's heat shield, but conceded Tuesday they may never find definitive proof that is what happened. The chairman of the Columbia Accident Investigation Board said he can live with the strong circumstantial case built so far, even though he understands some want to see the smoking gun that proves beyond any doubt "the foam did it." "That's not the kind of report we're writing," said Harold Gehman, the retired Navy admiral who also led the investigation into the terrorist attack on the USS Cole. "We don't have to prove which bracket broke in order for our report to hold together." Instead, the broader goals are to identify broader problems -- which will include preventing foam debris on launch -- that ultimately will "make the shuttle safer to fly," Gehman said. The investigation board Tuesday spelled out its "working scenario" of what happened to shuttle Columbia on Feb. 1. The announcement included no surprises. The board has found: * There is "ample evidence" that 81 seconds after liftoff, a triangular block of foam broke off the shuttle's external tank and struck the orbiter's left wing. * The foam struck the bottom of the row of backwards C-shaped reinforced carbon panels that form a heat shield protecting the front edge of the wing, specifically panels numbered 5 through 9, the ones closest to the left landing gear wheel well. * After the accident, Air Force Space Command reviewed radar tracking data and discovered an object floated away from the orbiter on its second day in space. Three months later, radar analysis has determined the only orbiter parts consistent with the radar data would be part of one of the reinforced carbon-carbon panels or metal T-seals that fit between those panels. * On Feb. 1, Columbia entered the atmosphere with unknown damage to one of those panels or T-seals on the left wing. * Strain and temperature readings extracted from a flight data recorder point to heat entering the area of panels 8 and 9 first. Melted metal deposits and nearby tiles recovered in Texas indicate components near panels 8 and 9 were exposed to extreme heat longer than other components. * Superhot gas, perhaps 3,000 degrees or more, entered through a hole created by a broken panel or T-seal. Temperature sensor readings indicate the gas first overheated the cavity between the panels and the flat aluminum spar at the front of the wing. The pattern of sensor readings and failures show, within two minutes, the heat burned through the spar and spread through the wing. * Within four more minutes, at least 164 sensors failed. Most were in the left wing or connected to wire bundles in the wing. * By then, 8:56 a.m., several pieces of the wing already had fallen away from the ship as it flew over the western United States and hot gas had found its way inside the left landing gear wheel well, providing the first data that alerted ground controllers to a problem. * The left wing, probably changing shape because of the rapidly-developing damage, began to cause drag that the flight computers tried to correct by firing control jets to try to keep the vehicle pointed straight ahead. Several NASA officials testified Tuesday morning, offering data and analysis that bolstered the board's scenario. The establishment of the working scenario, completed during the past 10 to 14 days, marks a turning point in the investigation. It provides a framework for the board's future work on the technical cause, which now will focus on attempting to prove the theory. It's also a big step toward closing out the technical aspect of

the investigation and moving on to the larger cultural and contextual issues. ["Panel agrees foam likely made hole in wing," **Florida Today**, May 6, 2003, p 1A & 2A .]

May 8: Lawmakers and the board investigating the shuttle Columbia disaster are locked in a dispute over congressional demands for access to information gleaned from hundreds of "privileged interviews" that investigators have conducted with NASA officials, engineers and others directly involved in the failed mission. Although the board has conducted nine public hearings into the Feb. 1 accident that killed the seven crew members, the most sensitive testimony about NASA decision-making and management practices has been taken behind closed doors. Board Chairman Harold Gehman, a retired admiral, has said he's more concerned about pinpointing the causes of the accident and recommending corrective changes than in publicly pointing a finger of blame. But key Republicans and Democrats on the House Science Committee said Thursday the testimony from 200 witnesses is essential to their understanding of the accident, and they vowed to press Gehman and the board for access. The lawmakers, including Science Committee Chairman Sherwood Boehlert, R-N.Y., Rep. Dana Rohrabacher, R-Calif., and Rep. Bart Gordon, D-Tenn., said they received assurances during a meeting with Gehman last week that they and their staffs could see expurgated copies of the transcripts, with the names of the witnesses removed. They said they were also promised full access to other data and materials generated by the probe. "As long as confidentiality is being taken care of, there is no reason for members of Congress not to see all the information that has been available to the board during this investigation," said Rohrabacher, chairman of the space and aeronautics subcommittee. "Members of Congress are elected by the people in order to look at information." However, Gehman said in Houston this week that the transcripts of closed-door interviews "are never going to see the light of day" and that "my offer (to Congress) does not include looking at privileged witness statements." ["Lawmakers seek access to NASA testimony," **Florida Today**, May 9, 2003, p 1A & 3A.]

◆ The shuttle has cost the lives of 14 astronauts in just 113 flights and is not safe enough to keep flying with people on board, a Texas congressman said Thursday. Rep. Joe Barton, a member of the House Science Committee's space and aeronautics panel, wants the government to build a new, safer space vehicle or modify the shuttle so it can be flown unmanned. Barton, R-Texas, said the shuttle accident rate of one every 62.5 missions "is simply not acceptable." In comments at a subcommittee hearing on NASA's plans, he urged the space agency to abandon the shuttle and find a safer way to fly into space. "If we had that safety record even in combat aircraft people would be appalled," Barton said in a telephone interview. He said the shuttle "is an unsafe system and it is technically impossible to make it safe enough, in my opinion." Instead of fixing the shuttle, Barton said it should be grounded or converted to a craft that flies unmanned. "The time has come after two accidents for us to shut down the orbiter (shuttle) and build a newer, safer spacecraft," he said. "If we have to stop manned spaceflight for five or 10 years, then so be it." Told of Barton's comments, NASA's administrator, Sean O'Keefe, declined to comment. In response to another question, O'Keefe said at a news conference that human involvement in space flight is essential for building the International Space Station, the massive orbiting laboratory now being assembled. ["Lawmaker: Shuttle manned shuttles," **Florida Today**, May 9, 2003, p 3A.]

◆ NASA will appoint an independent assessment team to scrutinize the space agency's plans to return the grounded shuttle fleet to flight. It will be led by Tom Stafford, a former astronaut, Air Force general and private industry executive who has been appointed to lead a number of NASA safety committees in recent years. NASA has not yet formally announced the team. It was revealed in testimony given to a congressional panel Thursday by Fred Gregory, the agency's deputy administrator. "The other panel members have not been named yet," said retired Air Force Gen. Michael Kostelnick, who was at the hearing. Kostelnick oversees the space shuttle and space station programs at headquarters. The Stafford team will review NASA's actions before the shuttle fleet returns to flight. It also will provide its judgments to the agency, the White House, Congress and the public, Kostelnick said. ["Ex-astronaut Tom Stafford to lead flight plan review," **Florida Today**, May 9, 2003, p 3A.]

May 9: NASA's Kennedy Space Center has issued a Request for Information (RFI), seeking organizations interested in using debris from the orbiter Columbia in researching the effects of reentry. Scientific, academic and governmental organizations interested are asked to submit their requests by June 6, 2003, detailing their previous experience, plans for use of the orbiter debris, and the scientific benefits expected

to be gained by their research. "This is a general request to organizations outside the NASA family," said Mike Leinbach, Columbia reconstruction chairman and Shuttle launch director. "Through the efforts of outside researchers, we stand to learn a great deal regarding hypersonic and thermodynamic properties and their effects on spacecraft parts. This will greatly assist in the design and flight safety of future spacecraft." NASA has also requested input on how to best preserve and manage the debris from Columbia. ["NASA Considers Offering Scientific Community Opportunity to Study Shuttle Columbia Debris," **KSC News Release #35-03**, May 9, 2003.]

◆ NASA today announced the selection of William (Bill) W. Parsons as the new manager for the Space Shuttle Program. Parsons, the director of the NASA John C. Stennis Space Center (SSC) in south Mississippi, succeeds Ronald D. Dittmore, who announced his resignation April 23. "Bill is a talented leader, motivator, and he's deeply devoted to the success of the Space Shuttle program," said William F. Readdy, Associate Administrator of Space Flight at NASA Headquarters in Washington. "His management, technical experience, and dedication to safety are vital as we move forward and prepare to start flying again." Parsons has served as Center Director since August 2002. He was first assigned to SSC in 1997 as the Chief of Operations of the Propulsion Test Directorate. Parsons relocated to NASA Johnson Space Center (JSC) in Houston to become the Director of the Center Operations Directorate, and he later served as the Deputy Director of JSC. He returned to SSC in 2001, and he served as Director of the Center Operations and Support Directorate. "I welcome the opportunity to work with Bill. He knows the space flight family and he knows the Space Shuttle program," said Michael C. Kostelnik, Deputy Administrator for the International Space Station and Space Shuttle programs at Headquarters in Washington. "NASA is about the people who fly, fix, maintain and design our vehicles, and I know we've found a terrific leader to help guide the team through this difficult time." "This is a critical position for the agency as we begin to focus our Return to Flight efforts in the wake of the Columbia tragedy," said NASA Administrator Sean O'Keefe. "The Space Shuttle Program, the entire space flight community, and the nation will be served by Bill's great leadership. He will be missed by our colleagues at Stennis, but the benefits to all the NASA family will be tremendous." ["NASA Selects New Space Shuttle Program Manager," **NASA News Release #03-164**, May 9, 2003.]

May 10: NASA's failure to analyze the risks of shuttle debris hitting homes and people during re-entry accidents contrasts sharply with the extensive studies performed by the U.S. Air Force before launches from the nation's spaceports. It also differs from NASA planning for the re-entry and destruction of unmanned satellites. Before launches from Kennedy Space Center, Cape Canaveral Air Force Station and Vandenberg Air Force Base in California, military safety officers calculate where debris would fall in the event of a launch explosion. Those studies help identify and clear danger zones before launches from the coastal spaceports. The idea is to protect launch site workers, mariners and the general public from falling wreckage in case of an accident. Similar studies determine where parts of the shuttle's 15-story external fuel tank might land after being jettisoned about nine minutes into flight. Most of the tank burns up during its plunge back through the atmosphere, but some parts fall into the Indian Ocean and safety officers want to make certain debris doesn't fall on populated islands such as Madagascar, off Africa's southeast coast. Rules and procedures limit the probability that charred chunks of debris will land in populated areas. The size of predicted impact zones are limited to a so-called 86 square feet, according to NASA documents for several recently launched satellites. During the June 2000 re-entry of NASA's massive Compton Gamma Ray Observatory, NASA officials at the time said the agency would carefully control the satellite's re-entry because heavy chunks of debris were expected to pose an unacceptable threat to public safety. They remembered what happened with an uncontrolled re-entry, when chunks of the Skylab space station landed in western Australia because NASA had very limited control over how it came down. Luckily, no one was hurt or killed then. NASA took no chances with Compton, bringing it down early when they knew they could have full control of the satellite's path. "Enough of the spacecraft will survive to present an unacceptable risk to populated areas if Compton were allowed to re-enter in an uncontrolled manner," the agency said in a report. "More than six tons of metal debris is expected to survive the re-entry process and reach the surface of the Earth. The surviving debris fragments will be traveling at very high speeds." Consequently, agency controllers guided the spacecraft into a remote part of the Pacific Ocean about 2,500 miles from the Hawaiian Islands. Repeated notices to sailors were sent out to keep boat traffic out of the area. Web posted. (2003). [Air Force launch fallout analyses routine [Online]. Available WWW: <http://www.floridatoday.com/> [2003, May 10].]

May 11: NASA, with the aid of content management and caching technology, has begun consolidating content from thousands of its Web sites into its main site. The space agency has deployed software to make the site easier for NASA personnel to update and speedier for users to access. The massive project, which began with planning last summer, started with a mandate from NASA Administrator Sean O'Keefe, said Brian Dunbar, NASA Internet services manager. "This is really about the administrator's charge to everybody at the agency," Dunbar said. "One of the elements of our mission statement is to inspire the next generation of explorers. He's determined that the Web site is going to be part of that." The agency has more than 3,000 Web sites hosting 4 million pages of information, Dunbar said. Using content management software from eTouch Systems Corp., agency personnel can submit pages from those separate sites to be published on the main site as well. Ultimately, many of the 3,000 sites will be absorbed totally into the main site, while others will just contribute some content, Dunbar said. NASA has also implemented software from Speedera Networks Inc. that mirrors some of the main site's content to multiple servers spread across multiple locations. When users request information, it comes from the server closest to the user, speeding response times. "The NASA home page before we started doing this was housed on one server in the basement of NASA headquarters in Washington, D.C.," he said. "When we got into periods of high traffic it was hard to get to our site." The first phase of the new approach went live on Jan. 31 and quickly got a real-world test — the shuttle Columbia disintegrated the next day. "We went from [transmitting] two megabits per second to 175 megabits per second in about 20 minutes," he said. "If we had still been in our previous configuration, people would have been coming into us looking for information and most of them wouldn't have been able to get in." Web posted. (2003). [NASA rethinks Web site approach [Online]. Available WWW: <http://www.fcw.com/> [2003, May 11].]

◆ Civilian members of the board investigating the shuttle Columbia disaster -- outsiders who were added to reassure Congress and the public that the board would be fully independent of the space agency -- are actually being paid executive-level salaries by NASA. The agency quietly put the five civilians on the National Aeronautics and Space Administration payroll, at pay rates of \$134,000 a year, in order to take advantage of provisions that allow boards composed exclusively of "federal employees" to conduct their business in secret. If the civilians had not been hired by NASA, a federal law would have required the investigating board to meet publicly, justify any closed-door sessions and keep transcripts and minutes that would ultimately become public records. Each of the 13 board members is now classified as a federal employee. Besides the five civilians and chairman, other members include four active-duty military officers, two federal transportation officials and a NASA executive. And as a result, the board says it is legally permitted to meet in secret and promise "confidentiality" to NASA employees and others among the more than 200 individuals it has interviewed. Last Tuesday, board Chairman Harold Gehman Jr. said that transcripts of these interviews will be kept secret from the general public, and even from Congress. Said Gehman, a retired Navy admiral who is being paid at the rate of \$142,500 per year, "Those are never going to see the light of day." Gehman, in a prepared statement Friday night, said the board's motive was not to withhold information from the public. He added: "The board determined it could provide a much deeper and richer review of NASA policies and procedures if it employed standard safety investigation procedures, which are incompatible with [open-government] provisions." ["Board paid to ensure secrecy," **Orlando Sentinel**, p A1 & A12.]

May 12: Accident investigators plan to commission a scientific analysis to gauge the risk posed by shuttle Columbia to people and property under its flight path when the ship disintegrated Feb. 1. The risk analysis will combine population statistics, wind measurements, trajectory data beamed back from Columbia, and information on the size, shape, weight and location of recovered shuttle debris. The idea is to "compute the risks to people on the ground," according to a draft of a request for proposals the Columbia Accident Investigation Board plans to issue. The board will solicit companies that perform risk assessments for government and industry. The findings of the analysis then will be available to help judge the risks to the public when shuttles re-enter Earth's atmosphere and cruise toward landing sites on future missions. The analysis of debris field maps, trajectory data and U.S. Census records showed that had Columbia broken up less than a minute earlier, debris would have rained down on the southern suburbs of Dallas-Fort Worth rather than rural East Texas. Nearly three times as many people and three times as many homes would have been exposed to falling wreckage, the analysis showed. In 22 years of shuttle flights, however, NASA has never studied where wreckage would fall in a re-entry catastrophe. But the U.S. Air Force routinely does

that type of analysis prior to space launches. And NASA typically does similar studies before unmanned spacecraft fall back to Earth. The analysis to be sponsored by the Columbia accident board will mirror in many respects the type of studies done by the Air Force prior to space launches. ["Study will gauge risk of re-entry to civilians," **Florida Today**, May 13, 2003, p 1A & 2A.]

May 13: New tests show that it would have been very difficult for falling debris to inflict major damage on the tiles on the underside of the shuttle Columbia during its launching in January, a member of the board investigating its fatal accident said today. Tests in which engineers blast chunks of insulation foam at a mock-up of tiles on main landing-gear door of space shuttle could help rule out tile damage. The findings do not bear directly on investigative panel's working hypothesis that breach in leading edge of left wing, not its underside, admitted superheated gases when shuttle re-entered Earth's atmosphere on Feb 1, but could help rule out tile damage and lay groundwork for further testing of leading-edge hypothesis. Before the crash, NASA had data about debris striking tile, but little about impacts on reinforced carbon-carbon, the material from which the leading edge is made. The investigators started with the landing-gear doors because they thought the breach that doomed the Columbia might have occurred there; sensors recorded elevated temperatures in the wheel well. Further analysis has shown that the most likely area of impact was the leading edge of the wing. So the investigators have used tests on the door mock-up to calibrate their equipment, which includes a gun with a 30-foot barrel that fires chunks of foam at speeds of nearly 800 feet a second, or more than 500 miles an hour. The test assembly measures strain and acceleration in the target. Web posted. (2003). [Tests Help Rule Out Tile Damage as Cause of Columbia Loss [Online]. Available WWW: <http://www.nytimes.com/> [2003, May 13].]

◆ The second Atlas 5 rocket soared into space with a Greek satellite that could give a boost to coverage of the 2004 Summer Olympics in Athens. The rocket lifted off at 6:11 p.m. from Pad 41 at Cape Canaveral Air Force Station. The 7,165-pound Hellas-Sat telecommunications satellite will provide direct-to-home television and high-speed internet services for people in Greece. The only problem during the countdown occurred when two boats moved into the restricted area east of the launch pad. That delayed launch for 14 minutes. ["Atlas 5 lofts satellite," **Florida Today**, May 14, 2003, p 6A.]

May 14: Investigators of the Columbia accident have quietly tackled the sensitive question of how close the shuttle's seven astronauts came to surviving the fiery re-entry and whether NASA might have done anything to rescue them, the head of the investigating board told senators Wednesday. This line of inquiry did not begin until earlier this month – more than three months after the accident – because there were "too many emotions, too many egos," said retired Adm. Harold Gehman, chairman of the Columbia Accident Investigation Board. Testifying before the senate Commerce Committee, Gehman said this part of his inquiry was in its earliest stages, starting just 10 days ago. But Gehman said he already has concluded it is "inconceivable" that NASA would have been unable or unwilling to attempt a rescue for astronauts in orbit if senior shuttle managers and administrators had known there was fatal damage to Columbia's left wing. "If we find that something could have been done, then the benign bureaucratic decisions made earlier take on a whole new significance," Gehman said. Web posted. (2003). [Shuttle probe cites 'missed signals' [Online]. Available WWW: <http://www.msnbc.com/> [2003, May 14].]

◆ NASA Administrator Sean O'Keefe and the chairman of the panel investigating the Columbia shuttle disaster clashed repeatedly over the issue of shuttle safety at a congressional hearing Wednesday. On several key points -- including launch damage, safety inspections, and spy photos of shuttles in orbit -- O'Keefe and retired Adm. Harold Gehman, Jr., found themselves at odds during testimony before the Senate Commerce, Science and Transportation Committee. And Gehman said NASA's shuttle safety and engineering branches lack the funding, clout and independence they need to make their views known at critical decision points. "The safety organization, on paper, looks perfect," Gehman said. "But when you bore down you don't find any there, there." Gehman promised the Columbia investigation report will be like nothing the National Aeronautics and Space Administration, founded in 1958, has ever seen. "The intent of our board is to produce an independent analysis and review of not only this accident but a deep, rich, intrusive inquiry into the entire human space flight program," Gehman said. His 13-member panel hopes to produce a report before lawmakers break in August for summer recess. Wednesday's hearing was the first time O'Keefe and the investigation board chairman have appeared together before a congressional panel. Senators pressed Gehman to name the NASA officials responsible for key decisions during

Columbia's flight. Gehman declined and said that information would not be part of his board's charter. In his strongest statement to date on the subject, O'Keefe assured McCain that once the Columbia investigation board's report is delivered, the space agency will begin to hold people accountable for their actions. "There will be accountability," O'Keefe said. "This will not be ambiguous." ["Gehman, O'Keefe spar before panel," **Florida Today**, May 15, 2003, p 1A & 2A.]

May 15: A research and development team from Kennedy Space Center (KSC) recently used a new hazardous gas detection system to study volcanic emissions in Costa Rica. The new prototype system named the Aircraft-based Volcanic Emission Mass Spectrometer (AVEMS) also will have a direct application to the Space Shuttle Program. The AVEMS is a step toward an advanced system that will be able to detect toxic gas leaks and emissions in the Space Shuttle aft engine compartment and the crew compartment, providing an added level of protection for the astronauts and the vehicle. "For Shuttle applications, it was especially helpful that we had the opportunity to fly the system at altitudes of up to about 40,000 feet," said Dr. Richard Arkin, ASRC Aerospace Corp.'s lead designer. Arkin, along with NASA project lead, Dr. Tim Griffin and members of the KSC team used AVEMS to analyze gases vented from the Turrialba volcano in Costa Rica. The tests were conducted from the air and in the volcano's crater. The study was the first to sample and quantitatively analyze fresh volcanic gases in their natural state. Active vents in volcanoes, called fumaroles, produce toxic gases such as sulfur dioxide, hydrogen sulfide, and carbon dioxide which, if too concentrated, can be fatal. ["KSC Volcanic Research May Enhance Shuttle Gas Detection Systems," **KSC News Release #36-03**, May 15, 2003.]

◆ One of the United States' top spacecraft designers says the shuttle should be retired and the human space program suspended. Max Faget, who designed the Mercury space capsule and had a managing role in the design of every other U.S. human launch system, including the shuttle, Apollo and Gemini, said the nation should halt human space endeavors until a better vehicle can be built to put astronauts into orbit. A Boeing study shows such a replacement craft could be available in three years. Similar calls for grounding the shuttles and other harsh assessments of its safety have been growing during the past week from members of Congress and space policy experts who say the fleet is too unreliable, too old and too costly to continue operating. But such views have largely represented critics outside the circle of elite space engineers. He has received almost every commendation that exists for engineers and was inducted into the Ohio-based National Inventor's Hall of Fame earlier this year. "The bottom line is that the shuttle is too old," Faget, 81, said in a telephone interview Wednesday from his home near Houston. "It would be very difficult to make sure it is in good shape. We ought to just stop going into space until we get a good vehicle. If we aren't willing to spend the money to do that, then we should be ashamed of ourselves." The aerospace industry is already positioning itself for such an effort, industry sources say. Boeing Co. is studying two options for building a derivative of the shuttle that could be rushed into service within three years. Until then or until the shuttle flies, the National Aeronautics and Space Administration is relying on the Russian Soyuz capsule to get back and forth to the International Space Station. Faget director of engineering for human spacecraft design at NASA for 20 years, was blunt in his criticism of the growing U.S. reliance on the Soyuz. The craft ran into problems earlier this month when a three-man crew returning from the space station landed hundreds of miles off course. "It is like going down the highway and thumbing a ride," he said. "You can do it, but it isn't the best way to get around. It is really admitting defeat." NASA officials did not respond directly to Faget's comments, though they said the "shuttle he designed 30 years ago is not the shuttle of today," noting it has been upgraded and modernized. However, NASA engineers at the working level said privately that they regard Faget as "a giant in the space community whose opinions are worth more than anybody else's." Whether the technology of the existing fleet should be updated or a new fleet of spacecraft built is the subject of an intensifying national debate about the future of the U.S. human space program. At issue is how many billions of additional dollars the nation can afford for the program. ["Designer: Suspend human space program," **Florida Today**, May 16, 2003, p 11A.]

May 16: The world's largest and second-largest wind tunnels – built and operated by NASA/Ames Research Center in Mountain View – were closed Friday due to budget cuts and fewer defense contracts. The wind tunnels served for nearly 60 years as the testing grounds for dozens of aircraft – from fighter planes to helicopters to the space shuttle. Web posted. (2003). [Wind tunnels closed [Online]. Available WWW: <http://www.bayarea.com/> [2003, May 17].]

May 17: With the last truckload of Columbia wreckage delivered, the accident investigation board looked over the broken and charred remains of the space shuttle Saturday, paying especially close attention to what little is left of the left wing. A hole along the wing's leading edge doomed the spaceship during its dive through the atmosphere 3 ½ months ago. "We saw the things today which we believe are compelling pieces of evidence that tell us how the heat got into the vehicle and where the flaw started," said the chief investigator, retired Navy Adm. Harold Gehman, Jr. Gehman said he and other board members felt it was their duty to see the wreckage one last time as a group, before winding up their investigation and writing their final report. He hopes to have the report completed by the end of July. "There are a number of pieces of debris out here which are extraordinarily significant that contribute directly to our investigation, and we wanted to see if, as a jury, we came to the same conclusion that our experts have," said Gehman, standing in a Kennedy Space Center hangar filled with shuttle wreckage. Gehman said he sees no reason why NASA cannot resume shuttle flights, although he would not estimate when. Web posted. (2003). [Columbia's remains get last look before final report written [Online]. Available WWW: <http://www.cnn.com/> [2003, May 17].]

May 18: The two Mars Exploration Rovers are in the final stages of preparation for their launches scheduled for June 5 and 25. On May 11, fuel was added to the first spacecraft. Today, it is scheduled to undergo its second spin balance test. Last weekend, testers found an unusual power measurement in the probe, but they did not expect it to delay processing. The first one will be taken out to its launch pad May 27 to be put atop the Delta 2 rocket. This week, workers attached the second lander to its protective back shell. The rocket's first stage is ready on Pad 17B. The other stages will be added in the coming weeks. The rovers will attempt to land on Mars in January 2004. ["Punishing tests ensure Mars rovers ready," *Florida Today*, May 19, 2003, p 1A & 5A.]

May 20: The left wing of the shuttle Columbia "rang like a bell" when it was struck by debris from the external tank about 82 seconds after liftoff, a member of the Columbia Accident Investigation Board said today, describing another piece of evidence helping investigators get a clearer fix on the Feb. 1 accident. Dr. James N. Hallock, who has led much of the board's work on sensor evidence, said that a sensor near movable control surfaces called elevons recorded distinctive readings for about a second. During the turbulence of liftoff, those forces rise and fall by about one G, the normal force of gravity. But in that second, Dr. Hallock said, the readings bounced up and down with an amplitude of two G's. But the sensor reading does not establish beyond doubt that the debris caused any damage, he said. In a briefing given by the board today, a second member, Steven B. Wallace, said review of films from previous shuttle launchings had identified two additional cases in which debris came from an area on the external fuel tank called the bipod ramp, the source of the debris that struck the Columbia. That raises the total to 7, among the 70 liftoffs for which there is data. (On 43 more there is no visual record because they were at night or the bipod was hidden from the cameras.) . Web posted. (2003). [Shuttle's Wing Rang Like Bell When Debris Hit, Investigator Says [Online]. Available WWW: <http://www.nytimes.com/> [2003, May 20].]

◆ NASA could have staged a rescue mission to try to save shuttle Columbia's crew had managers recognized that fatal damage had been done to the ship's left wing, an agency study has concluded. The results of the internal study, done at the request of the Columbia Accident Investigation Board, differ sharply from earlier NASA assessments that concluded nothing could have been done to save the seven astronauts. Instead, the new study shows that NASA could have launched shuttle Atlantis on a mission in time to attempt a rescue. "It would have been high drama, but there was a realistic chance of launching Atlantis on a mission that would have had a reasonable chance of returning the crew," a senior investigator familiar with the study told *Florida Today*. The NASA study outlines a rescue plan that would have rivaled the successful effort to save the Apollo 13 crew in April 1970 for drama. A series of spacewalks could have been conducted in a bid to escort the five men and two women aboard Columbia to safe harbor aboard Atlantis. The spacewalks "would have been sporty, but they would not have been impossible," the investigator said. "But the scrambling of Atlantis looks like it could have worked, and Columbia could have stayed in orbit plenty long enough for Atlantis to get there." With the crew safe, crippled Columbia then could have been guided by remote control on a fiery descent into the ocean rather than exposing the public to more than 80,000 pounds of wreckage that survived the ship's Feb. 1 break-up over east Texas. Since the accident, several top NASA officials have told reporters that even if the agency had known that the shuttle

was doomed, nothing could have been done to save the crew. Outside accident investigators are questioning the assumption, and recently asked NASA to study the issue more thoroughly. The senior investigator, who spoke Tuesday on condition of anonymity, said the new study concluded that Columbia, which blasted off Jan. 16, and the crew could have survived in orbit for 30 days, which would have given NASA enough time to launch Atlantis. At the time of the accident, Atlantis was being readied for a planned March 1 launch to the International Space Station. The ship already had been mounted on a mobile launch platform and outfitted with an external tank and twin solid rocket boosters. Had NASA recognized the problem early on, the astronauts could have powered down all but essential systems to conserve Columbia's electricity until the rescue mission could be launched. Food, water and other supplies also would have been conserved on the ship. Atlantis could have rocketed off around Feb. 9 or Feb. 10 without skipping critical prelaunch safety tests, the senior investigator said. With a crew of three or four astronauts aboard, the shuttle then could have rendezvoused with Columbia two days later. With the two shuttles flying in formation, their open payload bays facing each other, two spacewalking astronauts would have ventured outside Atlantis. The spacewalkers then would have extended a pole between the two shuttles so they could move from ship to ship. The first order of business would have been delivering lithium hydroxide canisters and extra spacesuits to the Columbia crew. Lithium hydroxide is used in shuttles to scrub potentially deadly carbon dioxide from crew cabin air. Carting canisters of the substance over to Columbia would have extended the amount of time its crew could survive while the rest of the rescue unfolded. That scenario would have called for the Atlantis and Columbia crews to stage another three or four spacewalks. During each of those excursions, members of the Columbia crew, outfitted in protective spacesuits, would have used the pole between the shuttles to move into the Atlantis cargo bay before boarding that ship. Once Columbia's crew was safely aboard Atlantis, that shuttle could have returned to Earth with 10 or 11 astronauts. The scenario then would have called for NASA to guide Columbia on a remote-control atmospheric re-entry that would have ditched the damaged orbiter in the ocean to avoid endangering people on Earth. In order to pull off such a rescue, however, NASA would have had to recognize the severity of the damage to Columbia's left wing early on in the 16-day mission. Had that been the case, the NASA study shows two of Columbia's astronauts could have performed a spacewalk to examine the left wing. Any attempt to repair damage to the wing, however, would have been "problematic," the senior investigator said. ["Daring rescue may have saved crew," **Florida Today**, May 21, 2003, p 1A & 2A.]

◆ Arthur Stephenson, director of the Marshall Space Flight Center since 1998, announced Tuesday that he is stepping aside to assume an educational position within NASA. Stephenson, 60, will retire in January. His last day as Marshall director is June 15; no replacement was named. ["Director of Marshall Space Flight Center steps down," **Florida Today**, May 21, 2003, p 2A.]

May 21: A rushed launch of a rescue shuttle. Two orbiters drifting in tight formation at 17,500 mph. A series of harrowing spacewalks to move astronauts from one crippled shuttle to one that could bring them safely back to Earth. A rescue scenario conceived by NASA, at the behest of Columbia accident investigators, is loaded with all the angst of a Hollywood script. But former shuttle astronauts and flight directors say that kind of rescue mission is risky, but feasible, and once was among the contingency missions early in the shuttle program. "I'd fly it," said Norm Thagard, a veteran astronaut who flew on the shuttle, Russian Soyuz and Mir space station. The new scenario came out of a request by the Columbia Accident Investigation Board, which asked NASA to study what flight controllers might have done to save the crew if decision-makers realized early on that Columbia's heat shield would not hold up under the intense heat of atmospheric re-entry. "They talked about this kind of stuff early in the program, but it became impractical," Thagard said. Early predictions that shuttles would blast off from the Cape almost weekly never materialized because of financial and technical roadblocks. Turn-around processing ended up taking a lot longer than shuttle system designers once thought. Still, the ideas were there and special equipment was even made. Thagard and another former astronaut, Blaine Hammond, remembered being shown beach ball-like "personal rescue spheres" NASA had designed with basic life support systems for just such a rescue. The idea was that rather than carrying a full set of spacesuits on a shuttle, each astronaut could curl inside the rescue ball and be carried across the void by another spacewalker. The balls aren't used, but the astronauts said they're one example of the extensive thought NASA had given rescue flights. The orbiters have proven highly maneuverable and able to rendezvous with other spacecraft at incredible speeds, including Russia's Mir, the International Space Station and the Hubble Space Telescope. "Look, anytime you've got two orbiters flying that close together, sure it would be a big deal," Thagard said. "But

we've proven the orbiter can maneuver close in to satellites, so maneuvering close to another orbiter isn't a problem." Keeping Columbia's crew alive long enough to get Atlantis there would be among the bigger challenges, but one made easier because of the unique equipment aboard the ship because of the nature of its longer-than-normal 16-day mission. Columbia was outfitted with a special rack of extra oxygen and hydrogen tanks in its cargo bay, installed to help power experiments in the payload bay lab. By shutting down the science lab, shutting off all nonessential systems and using the resources in the extended-duration mission rack among other moves, flight controllers have told investigators Columbia could have sustained the crew perhaps as long as 30 days. ["Ex-astronauts: Rushed rescue viable, but risky," **Florida Today**, May 22, 2003, p 1A & 5A.]

◆ Shuttle engineers reinstalled a critical seal between two heat-shield panels on the leading edge of Columbia's left wing after performing potentially damaging tests to measure whether tiny cracks in the seal would grow. There is no evidence the testing harmed the seal or played a role in Columbia's Feb. 1 breakup over central Texas. However, the board investigating the accident contends the decision to reinstall the seal and fly it again raises troubling questions about the National Aeronautics and Space Administration's approach to safety and managing risk. Engineers flexed the U-shaped seal 400 times during October 1991 tests at a Rockwell International plant – now part of Boeing – in Downey, Calif. Workers then returned the part to Columbia, where it flew on another 17 missions until the orbiter's fatal return home. The T-seal was located between reinforced carbon carbon [RCC] panels 9 and 10, two of 22 such panels that line the leading edge of each wing. Details of the fatigue tests and a larger 1991 probe into cracked T-seals are contained in an internal May 8 report from shuttle engineers to the accident investigation board. The T-seal investigation began in the summer of 1991. Technicians at Kennedy Space Center preparing Atlantis for flight discovered cracks measuring up to 1.7 inches long in eight T-seals. Checks of Discovery in its KSC hangar found seven T-seals that had lost part of their outside coating or were cracked. Columbia was inspected while undergoing a routine overhaul in Boeing's Palmdale, Calif., facility. All of the orbiter's T-seals were removed; nine were found to have small cracks. Atlantis' eight cracked T-seals were replaced with spares. Discovery's seven damaged T-seals were returned to the manufacturer for repairs. The May 8 report provides no details on what happened to Columbia's cracked T-seals. Investigators on the accident investigation board agree it's unlikely the testing played any role in the disaster. ["Crucial T-seal stress-tested, then reinstalled," **Orlando Sentinel**, May 22, 2003, p A17.]

May 22: Despite a "massive disgorging" of e-mails from worried engineers during space shuttle Columbia's doomed flight, no one called a safety hot line or alerted high-ranking officials that the orbiter may have been mortally damaged during liftoff, the head of NASA says. Administrator Sean O'Keefe said he wants to find out whether "folks just didn't know about" the safety reporting system or something held them back. The reporting system was put in place after the 1986 Challenger disaster to provide a way for space program employees to "raise a red flag" without fear of retribution. "You don't need to demonstrate why you think you're right. All you've got to do is send up a flare and everything's going to stop. That's what that system was for, and obviously, its use or disuse is something we're going to have to look at more carefully," O'Keefe said Wednesday in an interview with The Associated Press. "There was nothing to suggest that folks in this process felt like they weren't being heard so therefore (they) went and used this system," he added. NASA now knows that a large chunk of fuel-tank foam insulation slammed into the vulnerable leading edge of Columbia's left wing during the January liftoff from Florida and, along with the Columbia Accident Investigation Board, suspects the debris led to the ship's destruction two weeks later. If he had known the severity of the damage, O'Keefe said he would have done everything possible to save the seven astronauts, possibly even mounting a risky rescue mission with another shuttle and another crew. As it turns out, a hole in Columbia's left wing let in scorching atmospheric gases and led to the shuttle's disintegration over Texas on Feb. 1. All seven aboard were killed. "I freely admit, guilty as charged, I'm a Pollyanna," O'Keefe said. "There is no way we would have ever, if we'd known what happened or had any idea that there was a problem on orbit, that we would have ever abandoned them. There's no way." O'Keefe noted that during the Apollo 13 mission, flight controllers did not have a rule book for how to safely bring back astronauts aboard a crippled ship that was hurtling toward the moon. "Even if the possibility would have been a slim percentage, we would have tried anything possible in order to make this happen, even to include the prospect of sending another orbiter," he said. Accident investigators have learned that Columbia could have remained in orbit for days longer than officials at the National Aeronautics and Space Administration initially thought. Shuttle Atlantis was about to go to the launch pad for an early March

flight, and its schedule could have been accelerated for a possible rescue attempt. O'Keefe said NASA is also looking to change the decision-making process used by its shuttle mission management team, which accepted an engineering assessment while Columbia was still in orbit that a chunk of flyaway foam had not endangered the spaceship. The same management team turned down requests by engineers for satellite images of the shuttle's left wing to assess the potential damage. Web posted. (2003). [NASA's O'Keefe Promises Study of Safety Reporting System [Online]. Available WWW: <http://www.space.com/> [2003, May 22].]

◆ Retired space shuttle astronaut Richard Covey has been chosen by NASA to lead an outside panel of experts to evaluate NASA's safety procedures as it prepares to return its remaining shuttles safely to flight. NASA Administrator Sean O'Keefe, speaking Thursday at a breakfast sponsored by the Main Street Republicans Partnership, said that Covey, a veteran of four shuttle missions, will lead a diverse group of experts to "oversee and laugh test" NASA's compliance with recommendations from the independent Columbia Accident Investigation Board. The board has been scrutinizing the cause of the Feb. 1 disaster that destroyed Columbia during its return to Earth and killed its crew of seven astronauts. Covey, a former Air Force test pilot, was pilot aboard shuttle Discovery in 1988 during the first mission following the 1986 Challenger disaster. He later commanded Endeavour on its 1993 mission to repair the ailing Hubble Space Telescope. Covey, O'Keefe said, will report to Retired Air Force Lt. Gen. Thomas Stafford, who is leading a broader effort to evaluate NASA's return to flight plans. O'Keefe said that the group is still being formed and that NASA will make a formal announcement soon. O'Keefe also said during the breakfast that he still expects the shuttle program to be able to resume flight operations late this year or in early 2004. The extent of changes NASA must make to resume flying, he said, will depend largely on the recommendations of the Columbia Accident Investigation Board. NASA already is working on a return to flight plan, but the final decision that it is safe to fly again will depend on the Stafford-Covey group's assessment that NASA has fully complied with the investigation board's recommendations, he said. "When they say we have complied, that's when we will fly," O'Keefe said. Web posted. (2003). [Former Astronaut Richard Covey to Lead Independent Shuttle Safety Panel [Online]. Available WWW: <http://www.space.com/> [2003, May 22].]

May 23: NASA Associate Administrator for Space Flight William F. Readdy today named David A. King as the new center director for the Marshall Space Flight Center, Huntsville, Ala. King is currently Marshall's deputy director and will succeed Arthur G. Stephenson when Stephenson steps down June 15. King, whose NASA career began in 1983, has held the number two position at Marshall since November 2002. In that capacity, he assisted the center director in managing a broad range of propulsion, space science and materials research and development work contributing to the nation's space program. "Dave's closeness to the people and programs at Marshall make him a natural selection," Readdy said. "His ability to make critical decisions under challenging circumstances, comprehensive knowledge of Space Shuttle systems, and his demonstrated leadership qualities are vital as we move forward with our 'Return to Flight' efforts." King has also played a key role in NASA's Shuttle recovery operations in Lufkin, Texas, beginning earlier this year. He was dispatched to Lufkin within hours of the accident and immediately began serving as the senior on-site NASA official, directing efforts to search for clues and recover debris from the Feb. 1 accident. He was instrumental in creating the critical initial work processes; establishing effective working relationships among numerous federal and state government agencies; and laying the foundation for the two subsequent NASA officials who would share responsibility for leading an effective recovery from the mishap. "There was no blueprint on how to manage a recovery effort of this magnitude. Dave's devotion and determination, and his ability to manage thousands of people across multiple disciplines was significant in the success of the debris recovery process," added NASA Administrator Sean O'Keefe. "He's committed to the safety and success of the Space Shuttle program, and I know his colleagues at Marshall are as pleased as I am about his selection." Prior to serving as deputy director at Marshall, King was director of Shuttle processing at NASA's Kennedy Space Center, Fla., where he managed and coordinated all Space Shuttle processing and launch operations, overseeing the work of approximately 5,400 civil service and contractor employees. ["David A. King Named Marshall Space Flight Center Director," **NASA News Release #03-181**, May 23, 2003.]

◆ Frustrated NASA engineers complained during Columbia's mission that blurry pictures hindered their ability to assess how badly Columbia's left wing was damaged by launch debris. Documents show the

Kennedy Space Center engineer who regularly studies launch films for possible dangers wrote to managers and a contractor while Columbia was in space, saying this was the latest case of unfixed camera problems limiting the number and quality of images his team needed to do its job. "This is simply unacceptable from an engineering perspective," ice and debris team engineer Armando Olui wrote in a Jan. 21 e-mail. Olui's note came after his team worked through a holiday weekend to analyze photos and video from the Jan. 16 launch to see whether foam debris from the external fuel tank badly damaged the orbiter's heat shield. "Unfortunately, the one film item that would have given us the best data for this was out of focus and unusable," Olui wrote in a follow-up message the next day to shuttle program managers at Kennedy Space Center. The messages were among a batch of records released by NASA this week in response to a Freedom of Information Act request by Florida Today. "As one can imagine, we were quite disappointed," Olui went on. "The extent of the damage on the orbiter is unknown at this point due to poor resolution of film data. I am not sure if (camera) E-208 would have given us the information we desire, but we certainly will not know now." The internal e-mails and documents shared among the NASA engineers and contractors show, for the first time, the high level of frustration NASA experienced trying to determine anything from still photos and video that might help colleagues in Houston who were making fateful decisions about whether Columbia could return home safely. The chief concern raised by the documents, however, is that the number and quality of launch images has been a lingering problem for NASA engineers, one they had been pressing a contractor to fix for some time before Columbia blasted off Jan. 16. "We simply don't have enough cameras available to afford any problems," Olui wrote during the mission. "The loss of one camera can be, and, is significant. This mission proves that, and then some." The pictures are taken by Johnson Controls, under a complicated contract structure that also involves the U.S. Air Force because the work is closely tied to the shuttle tracking done by its Eastern Missile Range. NASA gets the pictures from Johnson Controls -- some for public relations shots and others for engineering purposes such as Olui's post-launch safety reviews. Web posted. (2003). [Fuzzy Photos Stymied Studies of Columbia's Wing Damage [Online]. Available WWW: <http://www.space.com/> [2003, May 23].]

May 24: A group of Utah students have learned that their science experiment aboard the space shuttle Columbia was found in a Texas parking lot and still could produce useful data. The aluminum box of salt crystals, an experiment by students from Moab, was recovered in Nacogdoches, Texas, a day after the February 1 tragedy that killed seven astronauts. Lockheed Martin officials who organized the student experiments learned only last week that the Moab experiment survived the disaster. The salt crystal box had been placed in a temperature-controlled container in the cargo bay of the shuttle. Four tiny crystals survived that could allow the students to complete their experiment. In all, nine of 80 experiments carried by Columbia have been found inside metal boxes. Scientists opened the boxes earlier this month at Kennedy Space Center and believe at least five of the experiments will yield usable data. Web posted. (2003). [Student science project survived shuttle disaster [Online]. Available WWW: <http://www.cnn.com/> [2003, May 24].]

May 26: The Columbia Accident Investigation Board has identified about a dozen shuttle program safety concerns it will address in its final report, in addition to foam shedding from the Lockheed Martin external tank -- believed by many board members to be the direct cause for the loss of Columbia and her crew. As the board works in Houston, United Space Alliance technicians here at Kennedy last week sent the first six of 22 RCC panels from the orbiter Atlantis' left wing to Vought Aircraft Industries Inc. in Dallas for extensive testing assess their integrity. The move is a key step toward both returning the shuttle to flight with Atlantis and obtaining more data on RCC panels subject to fewer flights, and less exposure to the weather, than the older panels used on Columbia. United Space Alliance managers at Kennedy have been ready for weeks to ship RCC panels from Atlantis, then later Discovery and Endeavour, to Vought for intensive tests to verify their integrity -- an early board recommendation aimed at returning the shuttle to flight. But it was only last week that NASA cleared the company to ship initial panels for tests. The next six panels will not be sent until the first six are returned to Kennedy under the current strategy. Once the 44 Atlantis panels on both wings are checked, those on Endeavour and Discovery will be sent, unless such testing can be moved to Kennedy. ["Columbia Accident Probe Widens," **Aviation Week & Space Technology**, May 26, 2003, p 42.]

May 27: The launch of the summer's first Mars rover mission has been pushed back by at least three days to allow more time for engineering reviews. The Mars Exploration Rover-A was slated for a June 5 launch

from Cape Canaveral Air Force Station. Now, NASA is looking at launching the spacecraft no earlier than June 8. On Tuesday morning, workers moved the rover out to Pad 17A and hoisted it on top of its Delta 2 rocket. The rover can launch until June 19. The delay will not affect its Jan. 4 arrival at Mars. The second rover, known as Mars Exploration Rover-B, is still on schedule for a June 25 launch. ["Engineering reviews delay Mars rover mission," **Florida Today**, May 28, 2003, p 1B.]

May 28: Confidential interviews with shuttle workers at NASA and its contractors, "from line technicians all the way through management," found no one who believed that preflight safety inspections were adequate, a member of the independent board investigating the loss of the Columbia said here today. Brig. Gen. Duane Deal of the Air Force, said investigators had found that there were too few eyes on the shuttle during flight preparations. Inspections once carried out by NASA workers were conducted by contractors with little direct NASA oversight, General Deal said, and the number of inspections has dropped by nearly 80 percent. In addition, he said, some government-mandated inspections seem to be unnecessary. The discussions are part of a larger inquiry into whether the NASA safety culture has slipped, contributing to the disaster that destroyed the Columbia on Feb. 1. Web posted. (2003). [Inspections Were Lacking, Shuttle Panel Member Says [Online]. Available WWW: <http://www.nytimes.com/> [2003, May 28].]

◆ The board investigating the Columbia accident is examining whether NASA's heavy reliance on private contractors contributed to a pattern of increasingly sloppy maintenance inspections and a gradual acceptance of increased risk for the astronauts. NASA's main contractor on the shuttle program is United Space Alliance, a joint venture owned by Lockheed and the Boeing Company that in turn uses 2,240 subcontractors to run all facets of shuttle operations. The space agency turned over the day-to-day operations of the shuttle program to the contractors in 1996 as part of a major privatization experiment and pays them more than 80 percent of the shuttles \$3.9 billion annual operating budget. Retired Adm. Harold Gehman, chairman of the board investigating the Feb. 1 accident, said Wednesday that the probe, among other things is examining whether the performance-based contract was structured in a way that rewarded contractors for cutting corners or minimizing the significance of recurring problems in order to meet launch schedules. Air Force Brig. Gen. Duane Deal, another board member, said shuttle maintenance and production quality assurance had slipped, particularly at Kennedy Space Center. "We interviewed many people, from line technicians all the way up through management, and none of them out there agree that we're at the 100 percent point," Deal said. Deal partly blamed NASA's decision to shift responsibility for safety and maintenance inspections from the agency to the private contractors and to cut the number of inspectors from 40,000 to 8,500. ["Contractor use raises concerns," **Florida Today**, May 29, 2003, p 3A.]

◆ NASA might be asked to stage a space shuttle test flight before resuming full-scale missions to complete construction of the International Space Station, an accident investigator said Wednesday. Mounting such a qualification flight would allow NASA to validate any recommended design changes or gather data on the performance of shuttle systems. Retired Navy Adm. Harold Gehman, Jr., chairman of the Columbia Accident Investigation Board, said the possibility of such a demonstration flight "is a matter under consideration" by the panel. But he added it's unlikely the board will make such a recommendation. Also unlikely is a recommendation that NASA recertify all shuttle systems before returning its remaining three space shuttles to flight. However, the board might recommend the time-consuming effort as a long-term project. NASA now intends to fly its shuttle fleet until 2020. "My own personal opinion is that would not be a return-to-flight issue," Gehman said. "The recertification or requalification issue is related to the announced intention of NASA to fly these things for another 20 years. It's not our charter to address that issue, but we may comment upon it." ["Board considers shuttle demonstration," **Florida Today**, May 29, 2003, p 3A.]

◆ Engineers for the first time today fired a large chunk of foam insulation at a Fiberglass wing leading edge panel, knocking a so-called T-seal out of place and leaving a long gap between two panels. Such a gap on a real shuttle wing leading edge would provide an entry point for deadly super-heated gas during the descent from orbit. Today's test results, assuming no problems are found, mark the first concrete evidence supporting the widely held theory that a foam impact during the shuttle Columbia's launch doomed the orbiter and its seven-person crew by creating a breach in the left wing's leading edge. "Investigators are always a little cautious and there were no raised eyebrows, but it certainly is an interesting initial result," said a spokesman for the Columbia Accident Investigation Board. The tests are being conducted at the

Southwest Research Institute in San Antonio, Texas, using a nitrogen gas canon capable of firing large pieces of foam insulation at velocities of more than 500 mph. Earlier test runs focused on firing foam chunks at panels of heat-shield tiles like those on the belly of the shuttle. Today's test was the first using a large mockup of a wing leading edge. The goal was to collect engineering data to ensure the validity of future tests. Investigators eventually plan to fire foam at an actual shuttle reinforced carbon carbon panel taken from the shuttle Discovery that has a flight history similar to panels that were aboard Columbia. For today's test, a 1.67-pound chunk of foam with a volume of 1,200 cubic inches was fired at a fiberglass panel in RCC position No. 6. The foam was fired at a velocity of 779 feet per second, or 531 mph, striking the fiberglass panel at an angle of 20 degrees. The actual angle of impact in the Columbia foam strike is believed to have been less than that. The leading edge panels are attached to the wing spar with so-called T-seals. Each edge of an RCC panel fits into a T-seal that is bolted to the front of the spar. The result is an alternating pattern of RCC panel, T-seal, RCC panel, T-seal and so on. In today's test, the the foam strike caused the T-seal between RCC panels 6 and 7 to lift and pull away toward the outboard panel 7, the CAIB spokesman said, leaving an opening approximately 22 inches long. The width of the resulting gap varied from the thickness of a dime to more than a quarter inch. A suitcase-size chunk of foam insulation broke away from Columbia's external fuel tank 81 seconds after launch, slamming into the left wing around RCC panels 7 and 8 at more than 500 mph. Engineers have long suspected the impact caused damage that left the shuttle with an open breach when the crew began re-entry Feb. 1. Today's test is the first to provide concrete evidence such an impact could actually displace a T-seal. But the CAIB spokesman pointed out that fiberglass is 2.5 times more resilient to impacts than the carbon composite material making up a real RCC panel. And the angle of impact was different, imparting more energy than a lower angle-of-incidence impact. How those variables are balanced in upcoming tests aiming at an actual RCC panel will go a long way toward determining whether or not a foam strike could have doomed Columbia. Web posted. (2003). [Foam impact test causes significant T-seal movement [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, May 29].]

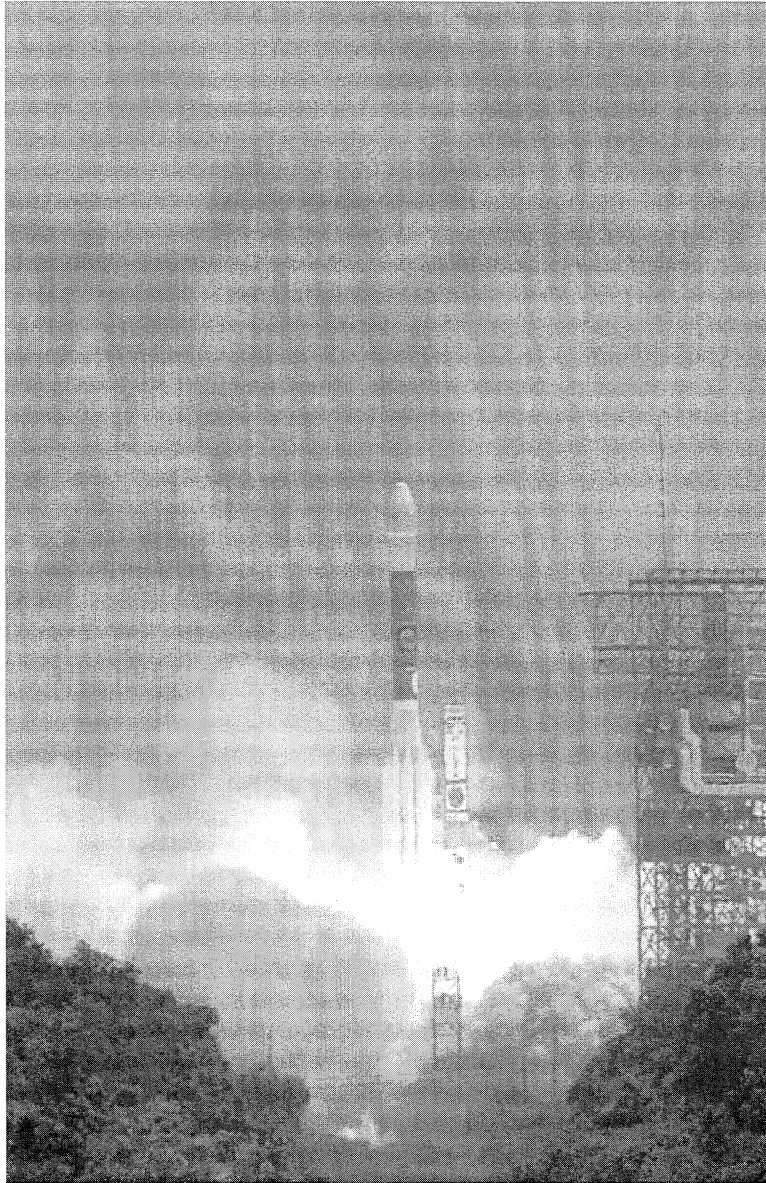
◆ NASA's Galaxy Evolution Explorer has gathered its first celestial images, a "first light" milestone dedicated to the crew of the Space Shuttle Columbia. The ultraviolet survey mission, launched on April 28 from Cape Canaveral, Fla., made the observations using its onboard telescope. To honor the contributions of the Columbia astronauts to scientific exploration, the Galaxy Evolution Explorer observed an area of the sky in the constellation Hercules. That region was directly above Columbia when it made its last contact to NASA Mission Control on February 1, over the skies of Texas. During the 16-day mission, the shuttle crew completed 82 science experiments. The Galaxy Evolution Explorer was the first NASA mission to launch since the Columbia accident. Its goal is to map the celestial sky in the ultraviolet and determine the history of star formation in the universe over the last 10 billion years. Web posted. (2003). [Galaxy mission honors Columbia crew with first light [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, May 29].]

May 31: NASA officials believe they can hire badly needed new workers if Congress gives the agency more power to offer bonuses and other incentives. Proposed legislation would give the space agency special authority to increase salaries for certain executives and offer recruitment, retention and relocation bonuses. NASA employees with critical skills would be eligible for bonuses equal to 50 percent of their annual salary multiplied by the number of additional years they agree to remain at the agency, up to four years. That's double the agency's current bonus limit. The legislation also would let NASA's administrator set annual salaries at \$198,600 -- the same salary earned by the vice president -- for as many as 10 top-level employees. A decade of downsizing and an aging work force have left the civilian space agency with a shortage of skilled workers. The agency's top three employment categories are aerospace engineers, general engineers and computer engineers, skills also in great demand in the private sector. "There are two challenges we're dealing with," NASA Administrator Sean O'Keefe said recently at a congressional hearing on the legislation. "The first one is that there are fewer and fewer folks who have the kind of skill-qualification mix that we're seeking. Our second problem is the kinds of tools we have available." O'Keefe said NASA could attract more graduate students, doctoral students and experienced workers if the agency had the power, for example, to forgive graduate-school loans. Critics of the pending legislation say it would give NASA an unfair advantage over other federal agencies. Web posted. (2003). [NASA aims to lure new workers [Online]. Available WWW: <http://www.floridatoday.com/> [2003, May 31].]

During May: The Homeland Security Dept. will study NASA's highly successful coordination of more than 130 federal, state and local agencies in the Columbia accident debris search for lessons on how to carry out similar coordination to respond to terrorist attacks. NASA and federal managers believe the Columbia debris recovery was the single largest organized ground search effort ever carried out, said David W. Whittle, chairman of NASA's Systems Safety Review Panel and head of the NASA Mishap Investigation Team in the Shuttle Program Office. The smoothness of the operation has impressed the HSD which has contacted NASA to review the effort, Whittle said. The search has been centered in north central Texas, but also extended east to Louisiana and west to New Mexico, Utah, Nevada and California. The command center for the search is being shifted from Lufkin, Tex., to the Johnson Space Center which will continue to process debris findings. The effort involved 30,000 personnel and cost \$300 million, paid for by the Federal Emergency Management Agency. More than 700,000 acres were combed on foot, while 1.6 million acres have been surveyed by air. At least 23 sq. mi. of lakes were surveyed, and U.S. Navy and civilian divers inspected nearly 3,300 underwater targets in larger Texas lakes and reservoirs. About 82,000 pieces of debris weighing 84,000 lb. have been recovered and shipped to Kennedy Space Center. This represented nearly 40% of Columbia. NASA expects a new surge in debris pickups in the fall when hunting season opens. ["Homeland Legacy," **Aviation Week & Space Technology**, May 12, 2003, p 33 – 34.]

◆ At least 11 major expendable booster missions remain to be flown at Cape Canaveral through the rest of 2004. These include five Boeing Delta II missions and two additional Delta IV Evolved Expendable Launch Vehicle flights. The Delta IVs include the first launch of the Heavy version in September that will use three oxygen/hydrogen-powered common booster cores with three Rocketdyne RS-68 engines as the first stage. At least one additional Lockheed Martin Atlas V EELV mission is also planned along with two Atlas IIIs and a Lockheed Martin Titan IV carrying a long delayed National Reconnaissance Office signal intelligence satellite. ["Busy at the Cape," **Aviation Week & Space Technology**, May 26, 2003, p 21.]

◆ Final processing of the two Mars Exploration Rovers set for launch on Delta II boosters June 5 and June 25 has involved the most intensive twin lander spacecraft assembly and checkout flow at the launch site here in more than 25 years. Unlike Viking where the two Mars landers were processed in different facilities, both rovers were processed in Kennedy's Payload Hazardous Servicing facility with a large 100,000-Class clean room. This has resulted in the unique scene here where about 25 engineers and technicians assigned to MER-1 have hovered over their spacecraft at one end of the room while a similar MER-2 team has worked on their rover at the other end of the same facility. In mid-January, the cruise stage and entry vehicle for one rover was shipped to Kennedy to begin early processing, while the first rover arrived here in mid-February along with the second cruise stage and entry system. Then in March, the second rover was shipped. About 100 JPL engineers and technicians have deployed to Kennedy for the two processing flows. Separate sets of mechanical and electrical test hardware were also brought to Kennedy so each lander could be put through facility-related tests independent of the other. Mechanically, the two rovers are the most complex unmanned spacecraft ever built and checked out at JPL and at Kennedy. ["Batteries Included," **Aviation Week & Space Technology**, May 26, 2003, p 58.]



Blue sky and sun are the backdrop for a flawless launch of MER-A, known as “Spirit,” the first of two Mars Exploration Rovers to be sent to Mars. Liftoff occurred on time at 1:58 p.m. EDT from Launch Complex 17-A, Cape Canaveral Air Force Station on June 10, 2003. When the two rovers arrive at Mars in 2004, they will bounce to airbag-cushioned landings at sites offering a balance of favorable conditions for safe landings and interesting science. The rovers see sharper images, can explore farther and examine rocks better than anything that has ever landed on Mars. The designated site for MER-A mission is Gusev Crater, which appears to have been a crater lake. The second rover, MER-B, is scheduled to launch June 25.

JUNE

June 2: NASA began accepting applications for mission specialist and pilot astronaut candidates to join the 2004 Candidate Class. Application deadline is July 1, 2003. The Astronaut Candidate Class of 2004 also will include educator astronauts, teachers who will join NASA's astronaut corps and encourage students to pursue studies in math and science. The Educator Astronaut Program (EAP) was announced in January, and applications closed April 30. Web posted. (2003). [NASA opens applications for new astronaut class [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, June 2].]

June 3: After traveling thousands of miles, two major components of the International Space Station completed the first leg of a journey that will eventually end 240 miles above the Earth. NASA's Node 2, built for the agency by the European Space Agency (ESA) in Italy, and the Pressurized Module of the Japanese Experiment Module (JEM) arrived in Florida and are being transported to the Kennedy Space Center (KSC) this week. "Delivery of these components, built in Europe and Japan, to KSC for integrated testing prior to flight is yet another indication of the significant global cooperation and proactive planning required for successful operation of the International Space Station program," said Bill Gerstenmaier, NASA's Station Program Manager. "Their arrival in the United States signifies the Space Station international partnership is continuing to move forward with the steps necessary to construct our unique research platform in space," he said. The arrival of Node 2, the next pressurized module to be installed on the Station, sets in motion the final steps toward completing assembly of essential U.S. components. When installed, Node 2 will increase the living and working space inside the Space Station to approximately 18,000 cubic feet. It will also allow the addition of international laboratories from Europe and Japan. The Pressurized Module is the first element of the JEM, named "Kibo" (Hope), to be delivered to KSC. The JEM is Japan's primary contribution to the Station. It will enhance the unique research capabilities of the orbiting complex by providing an additional environment for astronauts to conduct science experiments. An Airbus Beluga heavy-lift aircraft, carrying Node 2, departed May 30 from Turin, Italy, where the Italian Space Agency's (ASI) contractor, Alenia Spazio, built it. Following post-transportation inspections, ASI will formally transfer ownership of Node 2 to ESA, which, in turn, will sign it over to NASA. ["International Space Station Modules Arrive at Kennedy Space Center," **NASA News Release #03-190**, June 3, 2003.]

◆ Congress is close to reaching an agreement with the commission investigating the Columbia space shuttle accident that could provide access to secret testimony concerning the disaster, the chairman of the House Committee on Science said today. The chairman, Representative Sherwood Boehlert, Republican of New York, said at a news briefing that "negotiations were going very well" between the committee and the investigations group. They are close to an agreement that will allow committee members and some assistant to view the privileged testimony gathered in the investigation, he said. Web posted. (2003). [Shuttle Board May Open Files for Congress [Online]. Available WWW: <http://www.nytimes.com/> [2003, June 3].]

June 4: With the Columbia investigation winding down, NASA is discussing what to do with Columbia's remains. "We're pretty much done with the investigation," said Mike Leinbach, Columbia reconstruction team chairman. A preservation team will meet today with Kennedy Space Center Director Roy Bridges to present options for Columbia's remains. "She put up a hell of a good fight," Leinbach said. According to analysis of the debris, a breach formed in the front edge of the shuttle's left wing, on the underside of a reinforced carbon panel. A hole or gouge, most likely caused by a piece of breakaway foam during launch, allowed superhot gases to seep inside the wing during re-entry. Engineers could tell by the way the metal had melted and resolidified on the inside of those U-shaped panels. In June and July, any shuttle program worker can come to the hangar to study the ruined shuttle's debris. During the second week of July, Kennedy Space Center and Cape Canaveral employees will get a chance to walk through it. Then in mid-August, NASA will pack up the pieces of Columbia and move them into climate-controlled storage, although where is not exactly clear. For now, thousands of pieces are placed on a grid on the floor of the debris hangar. Blue tape outlines where the orbiter's wings and fuselage would be. On a tour, a group of about 15 was able to stand where the debris from the top of shuttle Columbia's left wing was placed. Very few pieces of that wing survived the breakup. "The key here is to show how much is not here," said

Leinbach. Web posted. (2003). [Fate of Columbia's remains uncertain as probe wraps up [Online]. Available WWW: <http://www.floridatoday.com/> [2003, June 4].]

◆ The Columbia Accident Investigation Board released results Wednesday from tests that documented significant damage when a small piece of foam struck a mock shuttle wing panel. The tests were part of the panel's effort to determine what caused Columbia to break apart February 1, killing all seven astronauts onboard. Investigators theorize that a piece of foam, which separated from the external fuel tank and hit the shuttle's left wing shortly after takeoff, caused damage to the orbiter's heat-resistant tiles or a seal between the tiles. On re-entry, the suspected breach would have allowed hot gases to enter and ultimately destroy the shuttle. Board member G. Scott Hubbard, director of NASA's Ames Research Center, told reporters Wednesday in Houston, Texas, that he was surprised by the results of the latest round of tests. "When I saw it, I thought, oh my God, this is something. This is not just a light force. This is a really significant effect," Hubbard said at the Center for Advanced Space Studies. The tests were conducted at the Southwest Research Institute in San Antonio, Texas. Researchers shot a piece of foam weighing 1.67 pounds at fiberglass panels from space shuttle Enterprise at a speed of 779 feet per second. That impact is comparable to catching a basketball thrown at about 500 miles per hour, researchers said. When the foam struck the fiberglass, it lifted and shifted the seal between two panels. The width of that opening was up to a quarter inch in some places. The foam itself broke into hundreds of small pieces, some of which lodged into panel gaps. The impact altered the surface of the fiberglass, leaving an indentation of about a tenth of an inch, investigators said. . Web posted. (2003). [Foam wedges into wing in shuttle test [Online]. Available WWW: <http://www.cnn.com/> [2003, June 4].]

◆ The man accused of trying to sell a collection of moon rocks and meteorites stolen by three NASA interns last year was convicted in federal court Wednesday. Gordon McWhorter, 27, faces up to 25 years in prison and \$250,000 in fines on charges of stealing property of value to the United States and interstate transportation of stolen property. McWhorter was the only one of the four defendants who was tried in the July 15 thefts from NASA's Johnson Space Center. ["Feds convict man in moon rocks theft," **Florida Today**, June 5, 2003, p 1B.]

June 5: With the launch of the first rover beginning the Mars Exploration Rover (MER) mission, the Kennedy Space Center web site is celebrating its first-time online coverage of an expendable vehicle mission. NASA Direct! will provide viewers with informative programming highlighting the objectives of the MER-A launch and the twin rovers' upcoming mission. During both programs, featured guests will answer questions submitted to the NASA Direct! Question Boards from space enthusiasts around the world. The NASA Direct! Home page and Question Boards can be viewed online at <http://www.ksc.nasa.gov/nasadirect/index.htm>. In addition to NASA Direct!, the KSC Web will provide live countdown coverage from the Virtual Launch Control Center. Coverage will feature real-time updating as milestones occur during the countdown, as well as downloadable and streaming video clips of countdown events. All videos are provided in RealMedia format. ["KSC's Expendable Vehicle Web Coverage Debuts With MER-A Launch," **NASA News Release #41-03**, June 5, 2003.]

◆ The launch of Mars Exploration Rover 2 is set for Sunday, June 8, at 2:05:55 p.m. EDT. Launch site is Complex 17-A, Cape Canaveral Air Force Station. The launch vehicle is a Delta 7925 rocket supported by nine solid rocket boosters. NASA's twin Mars Exploration Rovers are designed to study the history of water on Mars. These robotic geologists are equipped with a robotic arm, a drilling tool, three spectrometers, and four pairs of cameras that allow them to have a human-like, 3D view of the terrain. Each rover could travel as far as 100 meters in one day to act as Mars scientists' eyes and hands, exploring an environment where humans can't yet go. ["Mars Rover launch to put spacecraft on yearlong journey," **KSC Countdown**, June 5, 2003.]

◆ One ounce of radioactive plutonium will ride on each of the twin Mars rovers to launch this month. It's enough to draw protests, but probably not enough to harm residents in a disaster. NASA says the mission poses a 1 in 1,030 possibility of a radioactive accident near the launch site. And, even in the worst-case disaster scenario, people there would be subjected to less radiation than a single medical X-ray. "We really don't see them as a safety hazard," said Peter Theisinger, project manager for the Mars Exploration Rovers. Opponents say the government is downplaying the odds of an accident and its consequences. The

liftoffs of Mars Exploration Rovers A and B will mark the first time plutonium has been launched from Florida aboard a NASA spacecraft in six years. "We're taking all the precautions that we can think of," Kennedy Space Center Director Roy Bridges said. ["Mars rovers' plutonium not a threat, NASA says," **Florida Today**, June 6, 2003, p 1A & 2A.]

June 6: An enormous gas cannon fired a piece of foam against a copy of a space shuttle wing and put cracks in a leading-edge panel and in an adjoining seal. Those results could add further weight to the theory that the shuttle Columbia was doomed by the impact of a falling piece of insulating foam 81 seconds after being launched. "The first significant finding is that we cracked a rib on the structure," said G. Scott Hubbard, the member of the independent panel investigating the Columbia accident who is overseeing these tests. This was the first effort to shoot foam against the same material used in the leading edge of the wing, a composite called reinforced carbon-carbon. In this test, the composite panel and the adjoining seal were slightly dislodged, small pieces of foam were jammed in between them, and some foam sprayed within the wing. The crack in the panel runs three inches along the inside and about three-quarters of an inch on the outside, spidering away in a rough shape. A preliminary "tap test" suggested that the structure around the crack has been weakened, Mr. Hubbard said. Web posted. (2003). [Shuttle Tests Seem to Back Foam Theory in Accident [Online]. Available WWW: <http://www.nytimes.com/> [2003, June 6].]

June 7: Columbia accident investigators are questioning whether incentives and penalties within NASA's \$13 billion shuttle program contract could inadvertently compromise flight safety, jeopardizing astronaut crews. Of particular concern: Bonuses and profit cuts related to meeting launch schedules. Investigators want to know if such clauses might unintentionally prompt a contractor to cut corners or downplay the significance of recurring problems. So far, investigators have found no evidence of wrongdoing on the part of NASA's prime shuttle contractor, United Space Alliance, or USA, a private partnership of Lockheed Martin and The Boeing Co. Still, performance clauses in the contract are disturbing to investigators. "If you have a contract in which you can get paid bonuses for on-time launch, well, that instills a certain kind of performance in your contractors," said Retired Navy Adm. Harold W. Gehman Jr., chairman of the Columbia Accident Investigation Board. "If you're going to get paid bonuses for launching on time, then how many bonuses do you get for slowing the launch down?" According to the contract, none. In fact, USA can earn a \$2.87 million bonus for the timely delivery of a flight-ready shuttle. But the company can lose \$1 million in potential profit if a flight is delayed after NASA managers have cleared a mission for launch two days before a planned liftoff. The potential loss on each additional delay: \$500,000. Other clauses within the contract, however, are meant to serve as significant deterrents to putting launch schedules or cost cutting ahead of flight safety. For instance, USA stands to lose \$45 million if the company is found responsible in the Feb. 1 Columbia disaster, which destroyed a \$2 billion spaceship and killed seven astronauts. Alliance officials, meanwhile, say they are proud of the company's performance on the contract and are awaiting the findings and recommendations of the board. "Any financial impact to USA is obviously secondary to finding the cause of the loss of Columbia and her crew and to doing whatever is humanly possible to correct it, so that it never happens again," said Michael Curie, USA spokesman. ["Board questions shuttle contract," **Florida Today**, June 8, 2003, p 1A & 4A.]

◆ What do NASA's soon-to-be-launched Mars Exploration Rover (MER-1 and MER-2) spacecraft have in common with the Viking and Voyager spacecraft launched decades ago? Besides being interplanetary explorers, they will be among the biologically cleanest spacecraft ever launched from Cape Canaveral Air Force Station. Making sure the spacecraft are as biologically clean and contamination-free as possible before they leave Earth is NASA's planetary protection (PP) policy. It protects other solar system bodies from Earth life and protects Earth from extraterrestrial life that may be brought back by returning space missions. NASA's policy is based on the most recent understanding of planetary conditions and biology, and regular recommendations from the U.S. National Academy of Science. "Keeping the spacecraft as clean as possible before, during and after launch is very important for any science instruments searching for organic compounds on the surface of other planets," said Laura Newlin, Jet Propulsion Laboratory (JPL) engineer and Planetary Protection (PP) Lead for the MER missions. JPL's Biotechnology and Planetary Protection Group seeks to advance spacecraft cleanliness, sterilization and validation technologies for NASA's solar system exploration missions. "Up to 300,000 spores are allowed on the exposed surfaces of the landed spacecraft," said Newlin. "That many spores would fit on the head of a large pin." A companion requirement to this is the average spore density on the surfaces must be less than 300 spores per square

meter (28 spores per square foot). There are approximately 4,500 square meters (approximately 48,000 square feet) of surface on each MER spacecraft, including the cruise stage. When the spacecraft arrived at KSC from JPL in February and March, they were transported to the Payload Hazardous Servicing Facility in KSC's Industrial Area. Prior to that, the highbay and ground support equipment were cleaned, sampled and re-cleaned to reduce further biological contamination when the spacecraft arrived. Both spacecraft have since undergone extensive alcohol-wipe cleaning and bio-testing processes. They were disassembled and cleaned to remove any contamination that may have occurred during the cross-country transport. During reassembly, JPL PP team members sampled surfaces of both spacecraft to check for microbial spores. Culturing of the samples was performed in several KSC life sciences labs using equipment from JPL or provided by KSC including media clones, sonicators, water baths, incubators, microscopes, bio-safety hoods, and a large magnified colony counter. "Currently our total spore count on the surface of both MER vehicles is comfortably under 200,000. So we are below the allowable level," Newlin said. Web posted. (2003). [Rovers undergo biological tests, cleaning before launch [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, June 7].]

June 8: Twin robotic geologists NASA is sending to Mars will embody in their newly chosen names -- Spirit and Opportunity -- two cherished attributes that guide humans to explore. NASA Administrator Sean O'Keefe and 9-year-old Sofi Collis, who wrote the winning essay in a naming contest, unveiled the names this morning at NASA's Kennedy Space Center. "Now, thanks to Sofi Collis, our third grade explorer-to-be from Scottsdale, Ariz., we have names for the rovers that are extremely worthy of the bold mission they are about to undertake," O'Keefe said. Sofi read her essay: "I used to live in an orphanage. It was dark and cold and lonely. At night, I looked up at the sparkly sky and felt better. I dreamed I could fly there. In America, I can make all my dreams come true. Thank you for the 'Spirit' and the 'Opportunity.'" Hers was selected from nearly 10,000 entries in the contest sponsored by NASA and the LEGO Co., a Denmark-based toymaker, with collaboration from the Planetary Society, Pasadena, Calif. Web posted. (2003). [Mars rovers named 'Spirit' and 'Opportunity'[Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, June 8].]

June 9: Launch of the MER-A spacecraft aboard a Boeing Delta II vehicle scheduled for June 9 from Cape Canaveral Air Force Station, Fla. has been postponed for an additional 24 hours. Due to similar weather conditions today with approaching thunderstorms, mission managers opted to call off today's launch attempt prior to fueling the launch vehicle. The weather forecast for tomorrow is significantly improved with a 30 percent chance of violation of weather criteria. The launch times available for Tuesday, June 10 are 1:58:47 p.m. and 2:36:49 p.m. EDT. ["MER-A Launch Delayed for 24 Hours," **NASA News Release #43-03**, June 9, 2003.]

◆ NASA's latest attempt to outfit all of its field centers with common financial management software is in danger of meeting the same fate as two prior attempts that failed, according to the General Accounting Office, the investigative arm of the U.S. Congress. NASA, however, maintains that the current effort is on time, within budget, and when fully implemented will improve the agency's ability to keep track of its procurement dollars and produce accurate program cost estimates. The effort is known as the Integrated Financial Management Program, or IFMP. NASA has spent more than 12 years and \$100 million trying to develop and install a common financial management system across all of its field centers. The two previous attempts — both involving complicated, custom-built systems — bogged down and ultimately were abandoned. This time out, NASA is going with proven, off-the-shelf accounting software supplied by SAP Public Sector and Education Inc., based here. The agency also has hired the New York-based consulting firm Accenture to help with implementation and training. The first two field centers to be outfitted with the core financial component of the software — Marshall Space Flight Center, Huntsville, Ala., and Glenn Research Center, Cleveland — began using it in October. Four more field centers and the agency's Washington headquarters have since joined them. Four others are slated to be aboard by June 23: Stennis Space Center, Miss.; Dryden Flight Research, Edwards, Calif.; Langley Research Center, Hampton, Va.; and Goddard Space Flight Center, Greenbelt, Md. Before the transition began, each NASA field center had its own financial management system, making the tracking of program budget performance an imperfect affair. The pitfalls of relying on such a jumble of systems hit home in late 1999, when NASA managers discovered a looming \$500 million shortfall that nearly swamped the international space station program. NASA spokesman Robert Mirelson said the agency already is using the new system to manage the payroll

for its 18,000 employees, track travel expenses, and handle other personnel-related tasks. Beginning in early 2004, Mirelson said, NASA and its field centers will be able to use the software for budget formulation. The following year, the system will be expanded yet again to permit detailed tracking and analyses of NASA financial assets. Web posted. (2003). [GAO Issues Caution on NASA's Financial Management Plan [Online]. Available WWW: <http://www.space.com/> [2003, June 9].]

June 10: The MER-A Delta II launch vehicle carrying the "Spirit" Mars Exploration Rover was launched successfully from Pad 17-A at Cape Canaveral Air Force Station on Tuesday, June 10. The official liftoff time was 1:58:46.773 p.m. EDT. Communication with the spacecraft through the Deep Space Network indicates that the spacecraft is in good health and on the proper trajectory. There are no issues or concerns with the mission at this time. Bruce Buckingham. (2003). **ELV Status Report** [Online]. Available E-mail: domo@news.ksc.nasa.gov/subscribe shuttle-status [2003, June 13].]

◆ NASA Administrator Sean O'Keefe announced today, Dr. Jeremiah F. Creedon, Associate Administrator for Aerospace Technology is retiring after 40 years with the agency to join the faculty at Old Dominion University, Norfolk, Va., effective July 3. Creedon has held the position since June 2002. ["NASA Associate Administrator for Aerospace Technology Retiring," **NASA News Release #03-194**, June 10, 2003.]

◆ NASA has all but settled on a new design for a piece of space shuttle hardware suspected of having touched off the chain of events that led to the destruction of space shuttle Columbia Feb. 1, according to an agency official. The hardware in question is a fixture dubbed the bipod ramp, located near the attach point between the shuttle's external tank and the orbiter during liftoff. Columbia accident investigators believe insulating foam from Columbia's bipod ramp broke off during liftoff and struck one of the orbiter's wings, causing damage that may have led to its breakup during re-entry. Mike Greenfield, NASA's chief of technical activities, said the new design involves eliminating insulating foam from the bipod ramp. Briefing members of the NASA Advisory Council at agency headquarters here June 10, Greenfield said removing the foam and adding heaters to the bipod ramp emerged as the favored redesign candidate following an effort that examined multiple alternatives. The redesign proposal has been submitted to NASA's Program Control Review Board for final approval. Without the foam, the bipod ramp will require electric heaters to keep it from freezing. While the shuttle has many onboard heaters, the bipod redesign adds another electric component that has to be monitored for failure in the hours and minutes leading up to launch. Greenfield said the new design could be implemented in time for the Dec. 18 return-to-flight date for the shuttle orbiter fleet that NASA has chosen for planning purposes. If approved, the new bipod ramp design would be the first redesign approved since the Columbia accident and likely would be adopted officially before the projected July 25 release of the Columbia Accident Investigation Board report. Greenfield also told the advisory panel that NASA has decided to launch the shuttle only during daylight hours for the foreseeable future. That operating constraint will allow NASA to keep a close eye on shuttle performance during launches using specialized video equipment. Web posted. (2003). [NASA Redesigns Key Piece of Shuttle Hardware [Online]. Available WWW: <http://www.space.com/> [2003, June 10].]

◆ To honor the memory of the seven space shuttle Columbia astronauts, a 14,000-foot mountain peak in Colorado's Sangre de Cristo Mountains has been renamed Columbia Point. Columbia Point is located on the east side of Kit Carson Mountain. On the northwest shoulder of the same mountain is Challenger Point, a peak of the same height previously named in memory of the astronauts of the Space Shuttle Challenger, which exploded soon after liftoff on January 28, 1986. "The people of NASA and the families of the Columbia crew are humbled and grateful for this unique American honor that the Interior Department has bestowed upon the crew of STS-107," NASA Administrator O'Keefe said. "When people look upon these mountains, they see the challenge of the American frontier – bold in vision, courageous in spirit and endless in horizon. The crew of Columbia, like the Challenger before her had their qualities at the core. These mountains are a natural testament to their memory, their spirit of exploration and endure forever." Relatives of the Columbia astronauts joined NASA Administrator Sean O'Keefe and Secretary of the Interior Gale A. Norton at the naming ceremony held at the U.S. Department of the Interior in Washington, D.C. on June 10, 2003. Web posted. (2003). [Mountain Peak in Colorado Named in Memory of Columbia Mission [Online]. Available WWW: <http://www.space.com/> [2003, June 10].]

◆ Less than seven months from now, the world will watch as NASA tries to land its Spirit rover on the surface of Mars. Spirit launched on a Delta 2 rocket at 1:58 p.m. Tuesday from Launch pad 17A at Cape Canaveral Air Force Station. Before launch, Ed Weiler, NASA's associate administrator for space science, said only 5 percent of his concern applied to the launch. The other 95 percent are concerns about entry to Mars' atmosphere, descent and landing. Out of 30 worldwide missions sent to Mars, just 12 have succeeded. Scheduled landing of Spirit on Mars is January 4, 2004. ["Spirit rover Mars bound," **Florida Today**, June 11, 2003, p 1A & 3A.]

June 11: NASA mission managers failed to meet as often as required during shuttle Columbia's ill-fated flight, and investigators are questioning whether their performance contributed to the Feb. 1 disaster that killed seven astronauts. As engineers scrambled through a holiday weekend to determine the severity of a debris strike to the shuttle's left wing, NASA managers in charge of the mission did not hold a single meeting. Any chance of staging a rescue mission hinged on those managers recognizing the gravity of the situation early on. Key decisions had to be made by the end of the three-day weekend, Martin Luther King Day, in order to try to save the crew. Accident investigators are questioning "the presence and availability of key leaders" throughout the doomed mission, according to documents obtained by Florida Today. Also under investigation: The qualifications of the officials on NASA's Mission Management Team, which was responsible for shepherding Columbia's crew through its journey and dealing with any safety issues that cropped up during flight. Those factors raise questions about whether NASA's most experienced managers were fully engaged throughout a 16-day science mission that lacked the higher profile of a flight to the International Space Station. NASA Administrator Sean O'Keefe now recognizes the need to revamp the way the agency's Mission Management Team operates during future shuttle flights. "In terms of the on-orbit operation activity, that's going to change," O'Keefe told members of the NASA Advisory Council, an agency oversight board, earlier this week. Web posted. (2003). [Meeting delay may have doomed shuttle Columbia [Online]. Available WWW: <http://www.floridatoday.com/> [2003, June 11].]

◆ Boeing workers preparing the Delta 2 Heavy rocket for its launch of the second Mars rover got a loud surprise during a routine test at Cape Canaveral Air Force Station late Wednesday. They pulled on a lanyard that runs up the side of the rocket. The lanyard is part of the rocket's self-destruct system the Air Force would activate if the rocket flew off course. When they pulled, something that sounded like a small firecracker went off. The lanyard is attached to an initiator, which would activate the explosives that would destroy the rocket. The rocket is supposed to be equipped with dummy initiators until five days before launch, when the real ones are installed. The destruct explosives are added two days before launch. One of the two initiators was a dummy, but the other one was live, causing the bang. The rocket wasn't damaged, and no one was hurt in the event. The larger destruct explosives had not been loaded on board the rocket. "The main thing going on is a review of procedures," said Kennedy Space Center spokesman George Diller. He said managers will probably look for ways to make it easier for people to tell when live initiators are installed on the rocket. The Delta 2 Heavy rocket was initially supposed to deliver the Space Infrared Telescope Facility in orbit. But a few days before launch, mission managers decided to wait until August to launch the telescope, and the rocket was outfitted to take up the Mars Exploration Rover Opportunity instead. The initiator may have been accidentally left onboard from the telescope mission. ["Explosion startles rocket workers," **Florida Today**, June 4, 2003, p 2A.]

June 12: The Columbia Accident Investigation Board has agreed to give selected members of Congress limited access to statements from witnesses who testified to the board under an agreement of confidentiality. Retired Adm. Harold W. Gehman and members of the House Science committee negotiated the agreement after Gehman earlier had resisted giving members of Congress open access to the testimony. In a letter sent Thursday to the House Science Committee, Gehman said the investigation board would provide access to the committee chairman, Rep. Sherwood Boehlert, R-New York, and to the ranking minority party member, Rep. Ralph M. Hall, D-Texas. Authorized members of Congress may take unlimited notes from the testimony documents, the letter said, but these may not be released to the public. Gehman said that the same access was being offered to the Senate Committee on Commerce, Science and Technology. Web posted. (2003). [Shuttle investigators to release some confidential interviews [Online]. Available WWW: <http://www.cnn.com/> [2003, June 13].]

◆ NASA's Kennedy Space Center will extend its Joint Base Operations Support Contract (J-BOSC) for one year to Space Gateway Support (SGS) of Herndon, Va. The contract includes a modification to provide calibration services to the Eastern Range Precision Measurement Equipment Laboratory on Cape Canaveral Air Force Station (CCAFS) and transient alert aerospace ground equipment maintenance services at Patrick Air Force Base (PAFB), Fla. The contract extension/modification, valued at approximately \$287.7 million, covers October 1, 2003 through September 30, 2004. The total contract value, including exercised options, is more than \$1.5 billion. The J-BOSC is a performance-based, cost-plus award fee contract to provide base operation and support services at KSC, CCAFS, and PAFB. Under the contract, SGS provides facility and infrastructure operations and maintenance; fire protection, security services, transportation support, grounds maintenance, and other base support services. SGS is a joint venture of Northrop Grumman Technical Services, Inc., Herndon, Va., Shaw Infrastructure, Inc., San Diego, Calif., and Wackenhut Services, Inc., Palm Beach Gardens, Fla. ["NASA Exercises Base Support Contract Option," **NASA News Release #c03-s**, June 12, 2003.]

◆ The accepted theory of why a piece of foam broke off the shuttle Columbia's external fuel tank, presumably inflicting the fatal damage to its left wing, is "hokum," the chairman of the investigation board said. The assertion by the chairman, Harold W. Gehman Jr., a retired admiral, added to a growing sense that NASA still did not understand the operation of the shuttle fleet well enough to ensure that future flights would be safe, investigators said. Admiral Gehman agreed with another board member, Dr. Douglas D. Osherhoff, a physicist, who challenged the prevailing theory that the foam broke off the liquid fuel tank in a process involving condensation and boiling after air slipped beneath the foam. The two spoke in a briefing in which investigators said they had found new problems on an unrelated part called a bolt catcher that they had previously identified as potentially dangerous. None of the new problems change the working theory of why the shuttle was destroyed on re-entry, on Feb. 1. Panel members said that before shuttle flights could resume it was critical to determine exactly why the foam broke. Even though the part that shed the foam, the bipod ramp, will probably be stripped of foam on the next mission, other areas routinely shed smaller pieces of foam that hit the orbiter. The news about bolt catchers is also disturbing, the investigators said. The devices are supposed to protect the shuttle from bolts that connect the solid-rocket boosters, and for months the investigators have said they could not eliminate the possibility that a bolt fragment had hit the orbiter. NASA had a new supplier for the Columbia bolt catchers, and after the crash, tests showed that they failed at a much lower pressure than expected, said Maj. Gen. John L. Barry of the Air Force. Admiral Gehman said that investigators had gone back to look at quality assurance records and that those records "have us scratching our heads." Some post manufacture examination of the welds was apparently skipped, he said. Investigators publicly singled out the bolt catchers as a potential problem in April, and they join a list of factors that the board is having trouble ruling out. Those include damage to wing panels from previous flights or from improper handling on the ground or misinstallation of a panel. Web posted. (2003). [Shuttle Investigator Calls theory on Foam 'Hokum' [Online]. Available WWW: <http://www.nytimes.com/> [2003, June 12].]

June 13: Gen. Roy D. Bridges, Center Director for NASA's Kennedy Space Center (KSC), has been named Center Director for the agency's Langley Research Center, Hampton, Va. Gen. Bridges, a retired U.S. Air Force Major General and former Space Shuttle pilot will assume his new duties Aug. 10. Gen. Bridges was named KSC Center Director in March 1997. He was responsible for managing all of the agency's facilities and activities related to the processing and launch of the Space Shuttle and expendable launch vehicles, as well as final tests, preparations and processing of experiments and segments of the International Space Station. He also worked to develop the spaceport and range technologies to improve safety and reduce the cost of access to space. As a NASA astronaut, he piloted the Space Shuttle Challenger on mission STS-51F in July 1985. Gen. Bridges has held many key aerospace positions during his career. Prior to his last Air Force assignment at Wright-Patterson Air Force Base, Ohio, he was the Commander, Air Force Flight Test Center, Edwards Air Force Base in California. He also was Commander, Easter Space and Missile Center, Patrick Air Force Base, Fla; and Commander, 412th Test Wing, Edwards Air Force Base, Calif. Gen. Bridges has received numerous awards and honors. Most recently, he was awarded NASA's Outstanding Leadership Medal and the Presidential Meritorious Executive Award. Deputy Center Director James W. Kennedy will lead KSC as acting director for the time being. ["Gen. Roy D. Bridges Named Langley Center Director," **NASA News Release #03-197**, June 13, 2003.]

◆ Kennedy Space Center director Roy Bridges will move to Langley Research Center in August after a six-year tenure, NASA Administrator Sean O'Keefe announced Friday. The move – which Bridges said in a statement read to Kennedy employees caught even him by surprise – is the latest in a string of changes made by O'Keefe since taking over the agency just over 18 months ago. Deputy center director Jim Kennedy will become the acting chief, and he appears to be the leading candidate to replace Bridges, 59. Kennedy, who came to KSC in November, has worn a number of hats at NASA. He was project manager for the X-34, an experimental robotic rocketplane, has worked in shuttle engineering, as the head of the engineering directorate at Marshall and as manager of the Solid Rocket Booster Project. After announcing the move at a press conference at Langley, O'Keefe said his decision had nothing to do with the Feb. 1 loss of the space shuttle Columbia and everything to do with Bridges' depth of knowledge and his background as an engineer. As the National Aeronautics and Space Administration grapples with fixing the shuttle's problems and getting the remaining three orbiters flying again, O'Keefe said Langley's engineering expertise is more important than ever, and Bridges is the right man for the job of pushing ahead. [Kennedy Space Center to get new director [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, June 13].]

◆ Roy Bridges' tenure at Kennedy Space Center has been marked by management overhauls, the birth of the International Space Station and the cancellation of an expensive computer launch system for which he long fought. Bridges, who takes a job as director at Langley Research Center on Aug. 10, came on board as KSC director in March 1997. It was a busy year, filled with eight space shuttle launches, including the first re-flight of a shuttle after an aborted mission. NASA launched 31 shuttle missions during Bridges' command. They included John Glenn's return to flight and the first International Space Station construction mission in 1998 and this year's Columbia tragedy. One of Bridges' first projects was to develop a new computer system for launches to replace the one developed in the 1970s. Though it was supposed to save money, the system's climbing cost and delays prompted NASA Administrator Sean O'Keefe to kill the project last year. Bridges had campaigned hard for it, sticking to his original assertion that it was a 'must-do-and-deliver' project for us. We cannot support our mission without it." Workers found out about the end of the Checkout and Launch Control System from a manager during an impromptu mass meeting in a parking lot. That prompted O'Keefe to complain of "an absolutely outrageous display of poor leadership." Bridges oversaw KSC's efforts to make safety upgrades for facilities and the shuttles in spite of slim budgets and a pressing launch schedule. Bridges instituted safety "walkdowns" at the center in 1999, which also saw a five-month shuttle hiatus for wiring inspections of all the orbiters after Columbia had a nearly disastrous electrical short in flight. A similar pause occurred last summer, when cracks were found in the metal liners of fuel pipes in the orbiters. In 2000, Bridges instituted a broad restructuring of the center's work force. The International Space Research Park, a partnership between NASA and Florida, was founded in 2001, with construction of the Space Experiment Research and Processing Laboratory under way by 2002. NASA, the Air Force and Florida also unveiled a master plan for the Cape Canaveral Spaceport in 2002. Bridges promised more improvements for KSC itself last year. A new five-story office building is under construction near the Vehicle Assembly Building, designed to replace a fleet of dilapidated office trailers. ["Flights, overhauls mark Bridges reign," **Florida Today**, June 14, 2003, p 3A.]

◆ A ceremony to highlight the arrival of two major components of the International Space Station is scheduled for Wednesday, June 18 at KSC. NASA's Node 2, built by the European Space Agency (ESA) in Italy arrived at KSC on June 1. It will be the next pressurized module installed on the Station. The pressurized module of the Japanese Experiment Module (JEM), named "Kibo" (Hope) arrived at KSC on June 4. It is Japan's primary contribution to the Station. The ceremony will include the official transfer of ownership signing of Node 2 between the ESA and NASA. ["NASA Announces Space Station Module Welcoming Ceremony," **NASA News Release #N03-059**, June 13, 2003.]

◆ A former sheriff's deputy who helped gather debris from the space shuttle Columbia pleaded guilty Friday to stealing pieces of the wreckage. Jeffrey D. Arriola, took two small pieces of a wiring harness connector from the shuttle, which broke apart over east Texas on February 1. He could be sentenced to up to a year in prison and fined \$100,000. Web posted. (2003). [Deputy pleads guilty to stealing shuttle debris [Online]. Available WWW: <http://www.cnn.com/> [2003, June 13].]

◆ NASA Administrator Sean O'Keefe today said two veteran astronauts, Apollo commander Thomas P. Stafford and Space Shuttle commander Richard O. Covey, will lead a distinguished task force to access the agency's "Return to Flight" efforts and help implement the findings of the Columbia Accident Investigation Board (CAIB) when its final report is released later this summer. "The Stafford-Covey Task Force will aid NASA by assessing the agency's return to flight plans for the Space Shuttle and STS-114," said Administrator O'Keefe. The Stafford-Covey Task Force is made up of eminent experts and industry professionals. They come from a wide range of disciplines, with expertise in program management, engineer, hardware integration, safety, and systems evaluation. These initial members will oversee NASA's implementation of the CAIB's recommendations. They will work closely with NASA's Return to Flight team, led by Associate Administrator of Space Flight William F. Readdy and Associate Deputy Administrator for Technical Programs Dr. Michael Greenfield. Additional members will be added to the group throughout the implementation process. Web posted. (2003). [NASA Names Former Apollo & Shuttle Commanders to Lead Columbia Accident Report Task Force [Online]. Available WWW: <http://www.spaceref.com/> [2003, June 13].]

◆ A woman who left an anonymous message with a newspaper tip line suggesting she had found a mini-cassette from the space shuttle Columbia acknowledged to NASA today she did not have such a tape, an official said. Web posted. (2003). [NASA says shuttle cassette tape a hoax [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, June 13].]

◆ Shuttle investigators have agreed to give members of Congress limited access to hundreds of confidential interviews conducted with government workers and other in the four months after the Columbia disaster. The carefully worded compromise was reached after weeks of behind-the-scenes negotiations between lawmakers and the Columbia Accident Investigation Board. The board has interviewed about 200 NASA employees, contractors and others familiar with the space agency and the shuttles. Investigators agreed to keep testimony and identities confidential in order to learn as much as possible about NASA management and engineering decisions affecting shuttle safety. The technique has apparently worked well, as accident investigators have uncovered a series of troubling decisions and a lack of engineering understanding that leave the impression the civilian space agency did not know as much about shuttle-related weaknesses as its managers claimed. Members of Congress plan to conduct their own investigation in the fall. ["Congress will get access to some shuttle testimony," **Florida Today**, June 14, 2003, p 2A.]

June 14: As NASA tried to eliminate the dangers of falling foam insulation that apparently doomed the shuttle Columbia, independent investigators say they have found problems with four other shuttle components that could threaten future missions. Adm. Harold W. Gehman Jr., the Columbia Accident Investigation Board chairman said in a recent briefing that the members have warned against concluding that NASA's safety culture has eroded based solely on the circumstances of that accident. The four problems emerged after NASA and the Gehman board reviewed thousands of potential shuttle risks. The board also conducted hundreds of interviews, reviewed thousands of documents and ordered new experiments. An investigator said that in its final report to Congress, expected at the end of July, the board will probably use this analysis to conclude that NASA's safety culture is deeply flawed, regardless of what happened on the Columbia mission. NASA devotes enormous resources to finding and fixing problems in the short term, but it has not done enough to ensure that such problems will not reoccur, or that other problems do not happen that might otherwise be foreseeable. The most striking problem, investigators said, is the shuttle's "bolt catchers" – chambers built around the exploding bolts to catch pieces after the shuttle's solid rocket boosters break away from the external tank two minutes after launching. Radar monitoring of the Columbia launching showed unexpected debris falling 126 seconds in the flight, suggesting that a catcher might not have caught its bolts. Board members also discussed the "hold-down post assembly," which holds the shuttle to its launching pad before liftoff and releases it with explosive nuts. On a mission with the shuttle Atlantis in October, one of two triggers on one of the posts failed to fire. The second trigger did set off the nut, but board members said NASA might not have built in enough levels of redundancy to ensure a safe launching. Web posted. (2003). [Inquiry on the Shuttle disaster Finds a Variety of Problems [Online]. Available WWW: <http://www.nytimes.com/> [2003, June 14].]

June 15: Former astronaut Sally Ride, the first American woman in space, is participating in her second investigation of a shuttle disaster and acknowledges it's a discouraging way to mark the 20th anniversary of her historic flight. She has seen all the space shuttle program's warts up close, yet hopes that whatever is broken within NASA can be fixed and that the shrunken fleet will – and should – fly again, possibly a year from now. Even knowing all she knows from the investigation – about decision-making errors and flawed inspections – she'd fly the shuttle again if she were still in the astronaut corps. "It's got a lot of good years left in it, but attention has to be paid to aging," Ride said after another long day of Columbia investigative work. Ride acknowledged it's depressing to spend the 20th anniversary of her flight deciphering the events that led to Columbia's destruction and the deaths of seven astronauts. Ride rocketed into orbit and into headlines on June 18, 1983, on Challenger. It was two decades after the Soviets had sent a woman into space, but Ride, a physicist, was the first American woman to go up. She returned to space a year later, again aboard Challenger, and was training for her third and final mission when the shuttle Challenger accident occurred. Since Ride's famous ride, 37 women have flown on space shuttles. That represents about 13 percent of the total number of shuttle travelers. At present, women make up 21 percent of NASA's astronaut corps. Web posted. (2003). [Sally Ride marks anniversary [Online]. Available WWW: <http://www.cnn.com/> [2003, June 15].]

June 18: The space station processing facility looks like a garage for giants. The vast room at Kennedy Space Center is packed with big cans and trusses, many of them ready to fly on shuttles still grounded by the Columbia accident investigation. The Japanese module, a massive, gleaming metal cylinder that will be the largest pressurized piece of the station, is scheduled for a staggering 15 flights in the future. The two Italian cargo modules are draped with silvery covers, in storage mode. One will be on the next shuttle flight with the big round control moment gyro. The CMG will replace a malfunctioning gyro on the station, which has four that keep it oriented. Also waiting are several trusses, whose tightly folded solar arrays are prone to stick if kept in storage too long. Before the Columbia accident, the high bay was bustling with activity and anticipation of the station's "core complete" mode, which was then just a year away. Work has continued, but it is more measured. Even though the station isn't the focus of the investigation board, workers await the outcome of the Columbia investigation. ["Pieces of space-station parts stack up at KSC," **Florida Today**, June 18, 2003, p 1A & 2A.]

◆ European officials signed over to NASA on Wednesday a new node designed to link together several space-station modules, and one NASA official said December was a reasonable goal for the shuttles' return to flight. At the ceremony at the Space Station Processing Facility at Kennedy Space Center, Europeans celebrated the arrival this month of the Italian-built Node 2, while Japanese guests marked the arrival of the Japanese Experiment Module. "This program is all about friendships and partnerships and doing things together for the betterment of all of our civilization," said KSC Director Roy Bridges, who will become head of Langley Research Center in August. Several officials made speeches celebrating the historic cooperation involved in the International Space Station, expressing hope for an expanded crew in the future, and praising the work that continued in spite of the Feb. 1 accident that killed Columbia's crew. "We knew the right thing to do was to keep going forward," NASA station manager Bill Gerstenmaier said. ["Europeans sign over space station node to NASA," **Florida Today**, June 18, 2003, p 2A.]

◆ One of the remaining space shuttles is being overhauled and another is about to be, leaving only one orbiter available to meet NASA's timeline for getting the orbiters back in flight by early next year, according to the latest strategy presented to senior space agency officials. The proposed schedule calls for Atlantis to fly back-to-back missions to the international space station, probably in January and in May, to kick off NASA's recovery from the Columbia tragedy. The plan, outlined in documents obtained Wednesday by the Houston Chronicle, was presented to the directors of NASA's spaceflight centers and other officials on Friday by Jim Halsell, the astronaut who chairs the agency's return-to-flight planning team. The schedule of missions outlined in the document likely will be influenced by recommendations from the Columbia Accident Investigation Board, which is preparing its final report about the fatal Feb. 1 breakup of shuttle Columbia. The 13-member panel aims to complete its work in late July. NASA has instructed its shuttle prime contractor, United Space Alliance, to begin a round of major modifications and maintenance work on the 11-year-old shuttle Endeavour in July. The work, to be conducted at Kennedy Space Center in Florida, will include the installation of new electronic cockpit displays and other major upgrades, and could keep the youngest of the shuttle orbiters grounded until May 2005. The shuttle

Discovery began a similar round of upgrades and maintenance at Kennedy last year. The planned simultaneous work on Endeavour would mark the first time NASA has had two shuttles overhauled at the same time. The planning documents reveal a seldom-discussed consequence of Columbia's demise. Until the accident, the space agency had planned to modify the oldest and heaviest of its orbiters so that all four of the spacecraft were capable of space station duty. Columbia was to make its first journey to the 240-mile high orbital base in November. But with the loss of Columbia and plans to rotate one of the three remaining spacecraft through a lengthy maintenance process, only two spacecraft will be flying at any one time. Earlier this month, NASA Administrator Sean O'Keefe announced shuttle missions could resume as early as Dec. 18. While the planning documents reflect that intent, the materials also reveal that it will not be possible to launch until Jan. 21 if the space agency is constrained to daylight launches. Harold Gehman, who heads the investigative panel, has said the board might make that recommendation to ensure adequate lighting for ground-based tracking cameras. The cameras would be trained on each shuttle's ascent to record any debris striking the spacecraft. Web posted. (2003). [Overhauls leave NASA 1 shuttle available for goal [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, June 18].]

June 19: An instrumented mock-up of a shuttle wing was damaged Wednesday during a fourth test to determine if damage from a foam strike could have doomed shuttle Columbia and its crew. Hurling out of the barrel of a nitrogen gas gun, a 1.7-pound piece of foam insulation from a shuttle fuel tank slammed into the fiberglass wing mock-up at about 530 mph. The strike opened up a "pretty nice-sized gap" between a wing panel and an associated seal on the mock-up, said Air Force Lt. Col. Tyrone Woodyard, a spokesman for the Columbia Accident Investigation Board. "It was visible to the naked eye." A like-sized piece of foam broke free from Columbia's external tank 81 seconds after its Jan. 16 launch from Kennedy Space Center. The foam struck the shuttle's left wing in an area where hot gasses ultimately penetrated the ship, triggering the destruction of the craft during a Feb. 1 atmospheric reentry. Wednesday's results were similar to those documented during three previous tests, part of an ongoing series being conducted at Southwest Research Institute on San Antonio. Web posted. (2003). [Foam strike damages wing in fourth test [Online]. Available WWW: <http://www.floridatoday.com/> [2003, June 19].]

June 21: More than a dozen men and women who carried the nation's dreams into space came to the Astronaut Hall of Fame on Friday as the Kennedy Space Center Visitor Complex officially took charge of the tourist attraction. The festivities continued with a performance by the astronaut band Max-Q, meals with astronauts, autographs with cast member of "The Right Stuff" and the induction of four astronauts in the hall of fame: Sally Ride, Robert "Hoot" Gibson, Story Musgrave and Dan Brandenstein. KSC Director Roy Bridges cut the ribbon after Jim Lovell, the Apollo 13 commander who heads the Astronaut Scholarship Foundation, counted him down. A crowd of tourists and kids from KSC Space Camp applauded heartily for the spacefarers: Buzz Aldrin, Scott Carpenter, Gordon Cooper, Bob Crippen, Walt Cunningham, Owen Garriott, Ed Gibson, Fred Haise, Rick Hauck, Jack Lousma, Ed Mitchell, Al Worden and John Young. At "The Right Stuff" Gala, held at the Saturn V Center after the ceremony, several astronauts expressed confidence NASA's work would continue despite the Columbia accident. ["Famed spacefarers gather for star-studded KSC events," **Florida Today**, June 21, 2003, p 1A & 3A.]

◆ The Flight Readiness Review was held today for the MER-B launch of the "Opportunity" Mars Exploration Rover. Afterward, a decision was made to postpone the launch by at least a couple of days. Based on routine post-test inspections, the launch team has elected to remove and replace a band of protective cork insulation on the Delta first stage. The location is below the forward attach points of the strap-on solid rocket boosters. Inspections of a second band located higher on the first stage are being performed. The time necessary to do this work means a rescheduling of the launch to no earlier than Saturday, June 28 at 11:56:16 p.m. EDT. A firm date will be established on Monday after the engineering team reconvenes. ["MER-B "Opportunity" Launch Postponed," **KSC News Release #48-03**, June 21, 2003.]

June 22: Members of the panel probing why the space shuttle Columbia broke up on reentry plan to issue a few more interim recommendations to give NASA a head start on flying shuttles again, and then will try to grind out a final report before the end of July. Among recommendations the Columbia Accident Investigation Board (CAIB) will make "as soon as possible" is one calling for future mission management teams (MMTs), with overall responsibility for the conduct of shuttle flights, to be included in more

preflight integrated simulations. Typically shuttle crews and their ground controllers work together in the exercises – most of them at Johnson Space Center – handling simulated emergencies designed to meld flight and ground operations. [“Columbia Accident Investigation Board plans more interim recommendations before its final push to draft a report,” **Aviation Week & Space Technology**, June 22, 2003.]

◆ Lockheed Martin’s third Atlas 5 rocket – the first to fly in the 500-series configuration – rolls to the pad Monday for a full launch day rehearsal. Looking different than its two predecessors that successfully launched last August and May, the Atlas 5 AV-003 rocket will be sporting two strap-on solid rocket boosters and the base for a much larger nose cone when it emerges from the Vertical Processing Facility hangar. Riding on the mobile launching platform, the rocket will take the half-hour trip to the pad at Cape Canaveral Air Force Station’s Complex 41. By about 5 a.m., the platform should be secured at the pad for the start of preparations to fuel the rocket. The Atlas 5 rocket will carry the Rainbow 1 communications satellite into orbit. Web posted. (2003). [Mission Status Center [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, June 22].]

June 24: NASA today released recovered photographs and video taken by the crew of the Space Shuttle Columbia during its scientific research mission in January. The imagery was found during search efforts since the loss of Columbia Feb. 1. The Columbia Accident Investigation Board recently determined the material was not relevant to their investigation. The imagery documents the STS-107 mission from the crew’s perspective. The imagery includes almost 10 hours of recovered video and 92 photographs. It includes in-cabin, Earth observation and experiment-related imagery. The Shuttle carried 337 videotapes, but only 28 were found with some recoverable footage. The mission carried 137 rolls of film, but only 21 were found containing recoverable photographs. The imagery is among the more than 84,000 pieces of debris recovered. The debris weighs 84,900 pounds, about 38 percent of the dry weight of Columbia. More than 30,000 people assisted in the search conducted through the combined efforts of NASA, FEMA, EPA, the U.S. and Texas Forest Services. The Columbia Recovery Office at the Johnson Space Center (JSC) was established to continue accepting calls about debris, since the formal search was completed in April. [“New Space Shuttle Columbia Images Released,” **NASA News Release #03-212**, June 24, 2003.]

◆ The second of two Mars Exploration Rovers, Opportunity, is targeted for launch on Saturday, June 28 at 11:56:16 p.m. EDT. Liftoff will occur aboard the Boeing Delta II Heavy launch vehicle from Pad B at Space Launch Complex 17 on Cape Canaveral Air Force Station. A second launch opportunity exists at 12:37:59 a.m. EDT, if necessary. Should launch be delayed by 24 hours, the two launch times available are 11:46:14 p.m. and 12:28:07 a.m. EDT. The window of the planetary launch period extends through July 15. Opportunity will reach Mars on Jan. 25, 2004. Together the two MER rovers, Spirit and Opportunity, seek to determine the history of climate and water at two sites on Mars where conditions may once have been favorable to life. The rovers are identical. Each rover carries five scientific instruments including a panoramic camera and microscope, plus a rock abrasion tool that will grind away the outer surfaces of rocks to expose their interiors for examination. The rovers each weigh approximately 400 pounds. They will navigate themselves around obstacles as they drive across the Martian surface, traveling up to about 130 feet each Martian day. Each rover’s prime mission is planned to last three months on Mars. [“Opportunity” Mars Exploration Rover Targeted For Launch June 28,” **KSC News Release #50-03**, June 24, 2003.]

◆ Columbia accident investigators will recommend NASA toughen shuttles to make them less susceptible to deadly damage and develop ways to repair heat shield tiles in space. In a news conference here Tuesday, investigators also made their strongest statement yet on the cause of the Feb. 1 disaster, which killed seven astronauts. They said it was “highly probable” foam insulation that broke free from the shuttle’s external tank after its Jan. 16 launch dealt a fatal blow to the ship’s left wing, opening up a hole that ultimately enabled hot gases to tear the orbiter apart. “We believe that the foam is the most probable cause,” said Roger Tetrault of the Columbia Accident Investigation Board. Coming almost five months after Columbia disintegrated during an ill-fated atmospheric re-entry, the finding is based on a study of shuttle wreckage and evidence from a recovered flight data recorder. Both avenues of analysis show hot gasses penetrated the wing near the eighth of 22 composite carbon panels that protect it from intense heat encountered during reentry. The panel is where the wing sweeps away from the shuttle’s main fuselage. The

foam debris struck the wing in the same vicinity. "We think that when you look at the analysis of all the things that are pointing to the same area in terms of the hole, versus where the foam hit, that that's a fairly compelling story," Tetrault said. Investigators may never be able to definitively prove the foam strike was the direct cause of the accident because certain scenarios simply cannot be entirely ruled out as possibilities, he said. Web posted. (2003). [Board to advocate tougher orbiters [Online]. Available WWW: <http://www.floridatoday.com/> [2003, June 24].]

June 25: On the verge of declaring a breakaway chunk of foam as the cause of the shuttle Columbia disaster, the chairman of the board investigating the accident said Tuesday that NASA may be able to launch again sooner rather than later. Retired Adm. Harold Gehman, head of the Columbia Accident Investigation Board, said during a news conference that the grounded shuttle fleet may not need a major overhaul before launches resume. Instead, a handful of fixes -- some already being developed by NASA -- may be sufficient to fly again, with more comprehensive measures necessary later, he said. "I would say, having read every word of the draft report . . . I don't see any recommendations which are so difficult to accomplish that they shouldn't be able to return to flight in six to nine months," Gehman said. A 1.67-pound chunk of insulating foam broke off Columbia's external tank nearly 82 seconds after liftoff and struck the shuttle's left wing. For months, the board has been operating on the theory that the debris inflicted enough damage to allow superhot gases to penetrate the wing during re-entry and cause it to break apart over Texas the morning of Feb. 1. On Tuesday, board member Roger Tetrault said evidence gleaned from the recovered debris suggests the breach in the wing occurred around the bend in the shuttle's wing, in the vicinity of the eighth reinforced carbon-carbon, or RCC, panel. Twenty-two RCC panels make up the leading edge of each wing. Because of the conviction that the breach occurred around panel 8, he said, the board plans to conduct a test on fiberglass panels later this week or early next. A trial using the real panels is scheduled for July 7. Previous tests have shown the foam scenario is at least plausible. But, Hubbard said, the board is still looking for proof that the foam could cause a hole big enough to compromise the wing. As the board hunkers down to write its report, expected at the end of next month, NASA recently set a target date for its next launch of no earlier than Dec. 18 -- although agency officials acknowledge that timetable is mostly a benchmark for engineers working on changes and that spring of 2004 is more realistic. Gehman's comments seemed to reflect that the optimism of the National Aeronautics and Space Administration may not be unfounded. "There are a lot of things they have to do, but they look to me they're all doable," he said after the news conference. It is all but guaranteed that NASA will take the foam off the bipod ramp area of the tank -- the source of the foam that hit Columbia -- before it launches another shuttle. ["Shuttle could fly soon," **Orlando Sentinel**, June 25, 2003, p A1 & A8.]

June 26: William F. Readdy, Associate Administrator for Space Flight at NASA Headquarters in Washington, today named James W. Kennedy as the new Director of the agency's Kennedy Space Center (KSC) in Florida. Kennedy has served as KSC's Deputy Director since November 2002. He will succeed General Roy Bridges, who was appointed to lead NASA's Langley Research Center, Hampton, Va., June 13. "Along with his impeccable credentials, Jim brings stability to KSC at a time when we need it," Readdy said making the announcement. "As we prepare to implement the findings of the Columbia Accident Investigation Board, Jim's knowledge of the Space Shuttle and his leadership abilities are essential in making our 'Return to Flight' effort a success," he said. Prior to his assignment to KSC in 2002, Kennedy was deputy director of NASA's George C. Marshall Space Flight Center in Huntsville, Ala. Kennedy also served as project manager for major initiatives, such as the X-34 and the DC-XA, and he led the One NASA effort to help make the agency more effective and efficient by encouraging teamwork across all field centers. In early 1996, he was the manager for Marshall's Space Shuttle Projects Resident Office at KSC. Kennedy returned to Marshall when he received a Senior Executive Service appointment in September 1996 and was named manager of the Solid Rocket Booster Project. In 1998, he was selected as the Deputy Director of Science and Engineering, where he was responsible for establishing and maintaining a nationally recognized research and development capability in space research and technology. One year later, he became the Director of Engineering. ["James W. Kennedy Named Director, NASA Kennedy Space Center," **NASA News Release #03-217**, June 26, 2003.]

◆ NASA Administrator Sean O'Keefe tried to brace Kennedy Space Center employees Thursday for the findings of the Columbia Accident Investigation Board, whose report is expected in about a month. "When it comes out, it's going to be really ugly," O'Keefe said at KSC. "This is not going to be anything that

anybody's going to be particularly happy with at all." NASA already is working on fixes the report is expected to identify, he said, based on recommendations the board has discussed in public. KSC will have a large role in implementing the fixes on the three-orbiter fleet. Workers are expected to begin an overhaul of Endeavour and finish a refurbishment of shuttle Discovery next spring or summer, O'Keefe said Thursday afternoon at a press convention in Ponte Vedra Beach. "It's a perfect opportunity to take all of the findings and recommendations of the board," O'Keefe said, and apply new minimum requirements to the shuttles. The new requirements would include non-destructive testing of parts such as the reinforced carbon-carbon on the leading edge of the orbiter's wings, he said. A breach in the left wing's edge caused by a chunk of foam from Columbia's external tank is thought to have doomed the ship during its re-entry Feb. 1. NASA could beef up safety by employing experts who are independent of the deadline-driven programs that manage the shuttle and the International Space Station, O'Keefe said. While there are safety officials within those programs, NASA would "also create an organization that would have the capacity to look at trends and analysis of trends," he said, citing the frequent foam strikes on the orbiters' undersides as an example. While such a safety group is a good idea, O'Keefe said, it has to be managed carefully or else it "can drive you to the safest possible condition, which is, that you never fly." It would not have veto power over launches but would enhance the authority of NASA's top safety official in flight readiness reviews, he said. O'Keefe anticipates launching a shuttle by April, perhaps as early as December. In a meeting Thursday morning with employees, broadcast on closed-circuit TV at KSC, the administrator urged workers to concentrate on flying the shuttles and not get defensive when the report comes out. "People are counting on us to be very professional about this," he said. "It's going to be a lot about focusing on the future -- not apologizing for the past," O'Keefe said. But the administrator still anticipates "theatrics" from the media and Congress once the report is released. "I'm really strapping myself in," O'Keefe told employees. "I'm trying to find a Kevlar suit that I had somewhere, you know?" O'Keefe told reporters Thursday that the board will likely tell NASA to fix a problem, but it won't indicate how. NASA is trying to go beyond the recommendations and take extra safety measures. Bill Readdy, NASA's associate administrator for space flight, said the agency needs to understand better the complex air flow that occurs between the shuttle's orange external fuel tank and the orbiter. Investigators believe that foam coming off the tank during Columbia's launch struck the left wing and led to a gap that let in super-hot gas and eventually destroyed the orbiter and its seven-person crew. The agency also is redesigning an area on the tank called the bipod ramp, where the top of the tank connects to the orbiters. Investigators believe the errant foam originated there. Readdy said that workers are eliminating foam insulation from that region. Other NASA teams are examining whether inspecting and repairing the orbiter's heat-protecting tiles in space is possible, officials said. "Clearly, there are a number of advances in materials that have occurred over the last 20 years," Readdy said. "We aim to take advantage of those and look and see what concepts we might be able to apply." The board has said that if NASA follows its recommendations, the shuttle fleet could return to space in six to nine months. The Columbia debris in the Reusable Launch Vehicle hangar at KSC, meanwhile, is likely to be the subject of study for years, O'Keefe said. "One thing we're not going to do is what's happened with Challenger, is lock it up and bury it and pretend like it didn't happen," he said. Web posted. (2003). [O'Keefe: Report will be 'ugly' [Online]. Available WWW: <http://www.floridatoday.com/> [2003, June 27].]

◆ Another commercial satellite capable of taking detailed, close-up pictures of the Earth's surface was successfully placed in a polar orbit Thursday. The OrbView-3 spacecraft took its ride to space in the nosecone of an Orbital Sciences Pegasus XL rocket on a mission staged from Vandenberg Air Force Base, Calif. The satellite delivery mission began about 2 p.m. EDT (1800 GMT) when the winged Pegasus rocket took off from a Vandenberg runway, riding the belly of the company's L-1011 jumbo jet, dubbed Stargazer. The Stargazer mothership then flew to a point about 62 miles (100 kilometers) away, flying south over the Pacific Ocean, and dropped the Pegasus rocket at 2:53 p.m. EDT (1853 GMT) from an altitude of 39,000 feet (11,890 meters). Five seconds later the winged first stage ignited its solid-fueled main engine and began a 10-minute climb to orbit. All three solid-fueled stages worked well, according to reports from Orbital Sciences. Because spacecraft separation took place over the Pacific Ocean out of sight of a ground station, company officials could not immediately declare the launch phase of the mission a success. After circling the planet once, the OrbView-3 spacecraft's signal was picked up by a ground station in Alaska and officials reported everything was working fine. Web posted. (2003). [Commercial Imaging Satellite Rocketed into Orbit by Pegasus [Online]. Available WWW: <http://www.space.com/> [2003, June 26].]

June 27: Columbia accident investigators urged NASA on Friday to develop ways for astronauts to inspect damage and make emergency repairs in orbit before shuttle flights resume. The recommendation was the third made by the Columbia Accident Investigation Board in advance of its final report, which is due out in late July. NASA plans to launch its next shuttle mission sometime between December and next April. In a written statement, investigators said they are "convinced of the necessity of taking all practicable steps" to prevent foam debris damage to a shuttle's fragile heat shield from leading to a "loss of crew and vehicle." "An inspection and repair capability is fundamental to improving the ability of an orbiter to experience (thermal protection system) damage without catastrophic consequences," the board said. The directive "does not reduce the urgency or importance of aggressively reducing all sources of potential damage to the orbiter," the investigators added. "Only by reducing the likelihood of damage to the orbiter, as well as developing the ability to detect and repair damage, can the maximum safety improvement be realized." A suitcase-sized block of foam insulation broke free from Columbia's external tank 81 seconds after its Jan. 16 launch. The 1.7-pound foam chunk slammed into the shuttle's left wing in an area where hot gases ultimately penetrated the ship during its Feb. 1 atmospheric re-entry, destroying the shuttle and killing seven astronauts. Investigators consider the strike "the most probable cause" of the disaster. The board said astronauts should be equipped to inspect heat-shield tiles, panels and blankets early in every mission. What's more, future crews should have the means to repair potentially deadly damage while still in orbit, investigators said. Presently, there is no certified method for inspecting or repairing thermal panels that protect the shuttle's wings or heat-resistant tiles elsewhere on the ship. Web posted. (2003). [Board advises in-flight repairs [Online]. Available WWW: <http://www.floridatoday.com/> [2003, June 27].]

◆ NASA Administrator Sean O'Keefe said Thursday that he will open an "engineering and safety center" that will have more independence from shuttle flight managers and better abilities to look for the kinds of defects that doomed Columbia. O'Keefe announced the move as among a number of initiatives that will go beyond the already wide-ranging focus of the investigation board that is probing the Feb. 1 tragedy. Shortly after speaking at a convention of journalists in Ponte Vedra Beach near Jacksonville, O'Keefe said the safety organization would be set up at one of NASA's existing centers. Its expertise would include spacecraft structures, thermal protections and various materials used in space hardware, O'Keefe said. An additional duty would be to address hazards or concerns that occur during shuttle missions, such as the last flight of Columbia. The Columbia Accident Investigation Board is on the verge of formally concluding that the shuttle was fatally damaged nearly 82 seconds after liftoff Jan. 16 when a 1.67-pound chunk of insulation foam broke off the external tank and breached the spacecraft's left wing. Sensors, analysis of shuttle debris and other data indicate that superhot gases sliced through the breach during re-entry and destroyed the shuttle while it soared over Texas. The accident board has questioned whether NASA could have done more to detect the breach while Columbia was in orbit and organize a rescue of the seven astronauts. "We're going to have to make sure it [safety center] has the capacity and authority to have on-orbit operational influence," O'Keefe said, adding that NASA previously has had safety managers with that job but that they held less stature than managers in charge of spaceflight. O'Keefe, who spoke at the annual convention of the Florida Society of Newspaper Editors and the Florida Press Association, also said the safety center will have the ability to study trends, such as the routine shedding of insulating foam from the shuttle's massive external tank. "The fact that a foam strike, for example, occurred on every flight and didn't get any greater [each time] and didn't create any more damage was viewed as anomalous but not significant," O'Keefe said, adding that the new safety center will have the ability to say, "Wait a minute, why are you tolerating any of it?" O'Keefe would not elaborate on the number of employees or other details of the new NASA organization but said it would be in place "well before" shuttles fly again. Earlier Thursday, O'Keefe traveled to Kennedy Space Center to name veteran NASA manager Jim Kennedy as the launch site's new director. Web posted. (2003). [NASA to add new team to help safeguard shuttles [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, June 27].]

June 29: Launch of the MER-B "Opportunity" Mars Exploration Rover aboard a Boeing Delta II Heavy launch vehicle has been postponed due to upper level wind conditions at launch time. The next opportunity for launch is at 11:46:14 p.m. EDT, June 29. A second opportunity exists at 12:28:07 a.m. EDT, June 30. At this time, the weather forecast for the next launch opportunity shows a slight improvement with a 30 percent chance of violation of weather criteria. ["MER-B "Opportunity" launch delayed," KSC News Release #51-03, June 29, 2003.]

◆ Upon inspecting the first stage of the Delta launch vehicle after the January 28 launch attempt, engineers found that the lower band of cork insulation that was removed and replaced has limited areas that have debonded from the surface of the vehicle. Sections of this band, approximately ten percent of the circumference, will be reinstalled. The band of cork insulation around the vehicle is approximately 2 feet wide and ¼ inch thick. Based on the amount of time this work will require, launch has been rescheduled for Wednesday, July 2. There are two launch opportunities available: 11:17:37 p.m. and 11:59:54 p.m. EDT. ["MER-B Delta Launch With Opportunity Postponed to July 2," **KSC News Release #52-03**, June 29, 2003.]

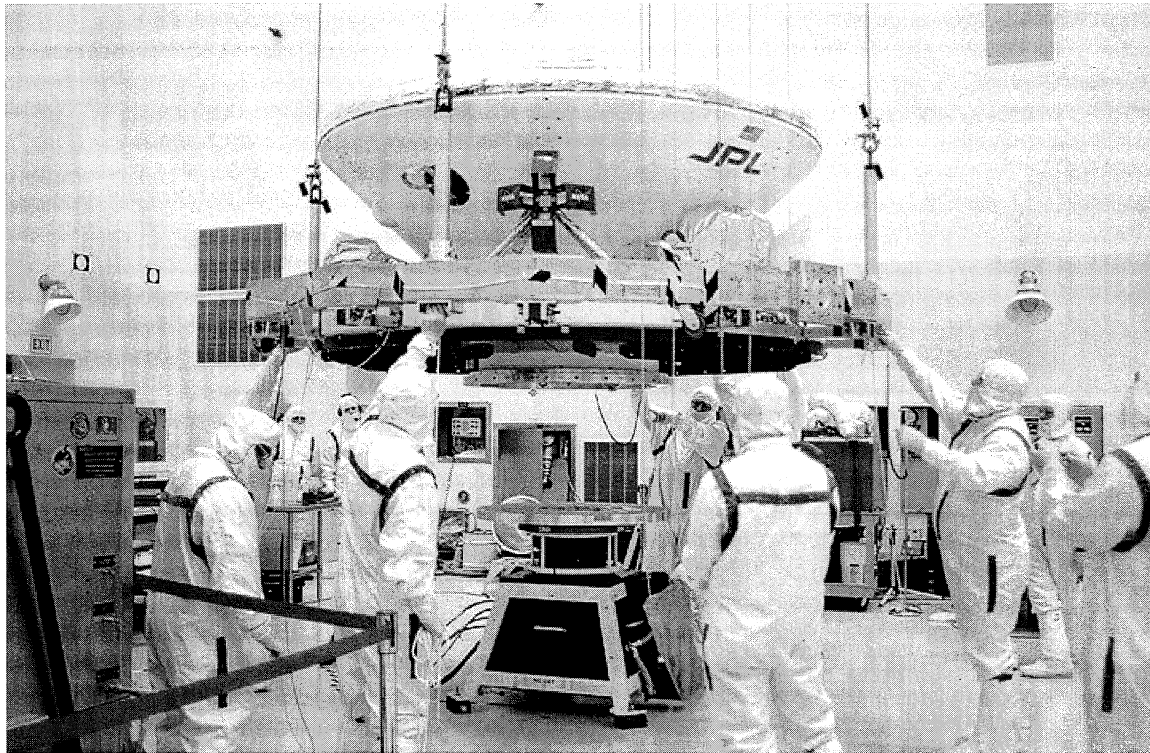
◆ Years of political wheeling and dealing helped lead shuttle Columbia to the launch pad in January and shaped its doomed final flight. Congress gave in to lobbyists and created Columbia's science mission using pork-barrel spending tactics. Deployment of a controversial satellite proposed by then-Vice President Al Gore was added as one of the research flight's objectives. The mission changed after Republican lawmakers stalled work on the satellite. Then, one of Columbia's seven astronauts, Israeli air force Col. Ilan Ramon, joined the crew as the result of a 1995 deal cut between President Bill Clinton and Israel's prime minister, Shimon Peres. "One can certainly use this mission as a way of understanding how the shuttle and NASA have as much to do with politics as science," said John Pike, director of the policy-analysis group GlobalSecurity.org. "Anyone who thinks this is mainly about science hasn't spent much time looking at the space program." Columbia's breakup over Texas on Feb. 1 and the death of its crew have given fresh ammunition to skeptics who question the rationale behind a human-spaceflight program mired in low Earth orbit for the past 30 years. Critics are urging that human lives and the \$3 billion spaceships not be put at risk unless there are clear and compelling reasons for doing so. However, an investigative board chaired by retired Navy Adm. Harold Gehman is not expected to address the issue in its final report expected next month. House members created what would become Columbia's final mission in October 1998 during final negotiations on the National Aeronautics and Space Administration's fiscal 1999 budget. Lawmakers anonymously added language to the bill at the last minute appropriating \$15 million -- an amount far short of the flight's estimated \$500 million total price tag -- for "a shuttle mission which accommodates research payloads." A lobbying campaign launched by Spacehab Inc. drummed up congressional support for the research flight. One NASA manager described the lobbying effort as "intense." NASA contracts with Spacehab to provide, among other things, the leased laboratory modules that are installed in the shuttle's cargo bay on research missions. NASA paid the company more than \$47 million for the onboard lab on Columbia's final flight. Spacehab suffered a \$50.3 million loss after the module was destroyed. The tactic Congress used to create the research mission is called earmarking. Lawmakers increasingly have employed the technique in recent years to quietly slip local pet projects into NASA's budget including fisheries, business jets, museum exhibits and gardening studies. More than \$1.7 billion has been siphoned from NASA priorities since 1998 to pay for pork-barrel spending. Those responsible for the earmarks aren't identified in the spending bills, meaning there is little to no accountability. Web posted. (2003). [Politics spawned Columbia mission [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, June 29].]

June 30: The launch of the MER-B "Opportunity" Mars Exploration Rover aboard the Boeing Delta II Heavy Launch vehicle has been postponed to no earlier than Saturday, July 5. A decision was made today to take additional time to perform tests on the process used to bond the cork insulation to the surface of the Delta II launch vehicle. These tests should be complete late on Wednesday. The launch times on Saturday evening are: 10:51:25 p.m. and 11:34:05 p.m. EDT. ["MER-B Launch of "Opportunity" spacecraft postponed to Saturday, July 5," **KSC News Release #53-03**, June 30, 2003.]

During June: Given the way the legislative year is playing out, there probably won't be enough time to draft a NASA authorization bill in the current session of Congress. That means the House and Senate Appropriations Committees get first shot at shaping space policy in the wake of the Columbia accident. The Columbia Accident Investigation Board is trying to finish in time for members to read its report during the August congressional recess. Those findings in turn will guide the way hearings into the accident and the space shuttle's future will be organized, according to Rep. Sherwood Boehlert (R-N.Y.), chairman of the House Science Committee. But those decisions won't be made until September at the earliest, and the hearings themselves may be held even later in the fall. Aides say the authorizing committees probably will draft a multi-year authorization next spring, but the appropriators can plug some post-accident language

into the NASA spending bill they expect to produce this year. [“Tight Schedule,” **Aviation Week & Space Technology**, June 9, 2003, p 21.]

◆ Top-level personnel shifts at NASA continue. Roy D. Bridges, director of Kennedy Space Center, has been moved to the same post at Langley Research Center, effective Aug. 10. With Bridges’ departure from the Florida launch facility, new directors or acting directors will be in place at all four field centers associated with human spaceflight – Johnson, Stennis, Marshall and Kennedy. Bridges will be replaced by his deputy, James W. Kennedy. Meanwhile, Jeremiah F. Creedon, associate NASA administrator for aerospace technology, will retire July 3 after 40 years with the agency. A former director of Langley, Creedon took the headquarters position in June 2002. Victor Lebacqz, associate director for aerospace programs at Ames Research Center, will take over as acting associate administrator at NASA Headquarters. [“Musical Chairs,” **Aviation Week & Space Technology**, June 23, 2003, p 17.]



In the Payload Hazardous Servicing Facility, the Mars Exploration Rover 2 (MER-2) is lowered toward the spin table. NASA's twin Mars Exploration Rovers are designed to study the history of water on Mars. These robotic geologists are equipped with a robotic arm, a drilling tool, three spectrometers, and four pairs of cameras that allow them to have a human-like, 3D view of the terrain. Each rover could travel as far as 100 meters in one day to act as Mars scientists' eyes and hands, exploring an environment where humans can't yet go. The MER-2 is scheduled to launch June 5 from Launch Pad 17-A, Cape Canaveral Air Force Station.

JULY

July 1: The Columbia Accident Investigation Board today issued its fourth preliminary finding and recommendation to the National Aeronautics and Space Administration, in advance of its appearance in the final report. Recommendation Four: Upgrade the imaging system to be capable of providing a minimum of three useful views of the Space Shuttle from liftoff to at least Solid Rocket Booster separation, along any expected ascent azimuth. The readiness of these assets should be included in the Launch Commit Criteria for future launches. Consideration should be given to using mobile assets (ships or aircraft) to provide additional views of the vehicle during ascent. Facts: Imaging the Space Shuttle vehicle during launch and ascent provides necessary engineering data including the ability to examine the entire Space Shuttle system for any unexpected debris or other anomalies during ascent. A variety of assets are already in place at the Kennedy Space Center (KSC) and on the Air Force Eastern Range (ER) to accomplish this task. Ascent data from the optical assets at KSC and the ER are reported to the Mission Management Team in the days following the launch. A "quick look" report is available the day after launch, and a more detailed analysis is available within a few days. For the most part, engineering quality ground-based data is not available in real time. During the STS-107 ascent, two ground-based long-range camera sites provided data that was usable for evaluating the foam strike against the vehicle. A third camera that would have provided a better view was unusable. Findings: The current long-range camera assets on the Kennedy Space Center and Eastern Range are inadequate to provide best possible engineering data during Space Shuttle ascents. Evaluation of STS-107 debris impact was hampered by lack of high resolution, high speed cameras (temporal and spatial imagery data). Board issues launch imaging recommendation [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, July 1].]

July 2: Space Shuttle Program Manager Bill Parsons today announced several key leadership changes within the office as it reorganizes and evolves following the Columbia accident. "This is a critical time for the agency and the shuttle program and I believe these changes and additions to my staff prepares us to return to flight as soon as possible and, most importantly, as safely as possible," Parsons said. N. Wayne Hale, Jr., is named Acting Deputy Manager, Space Shuttle Program. He will return to the Johnson Space Center from the Kennedy Space Center where he has served as Manager, Launch Integration, since February. Steve M. Poulos, Jr., becomes Acting Manager, Orbiter Project Office at JSC. He joins the shuttle program from the Engineering Directorate where he most recently was Chief, Crew and Thermal Systems Division. Edward J. Mango becomes Deputy Manager, Orbiter Project Office. He has been the technical assistant to the Space Shuttle Program Manager on detail from the Kennedy Space Center. John P. Shannon is named Acting Manager, Flight Operations and Integration. Most recently, he served as Lead Flight Director on Discovery's STS-102 mission in March 2001. Following Columbia's accident, Shannon served as the Deputy Director of the Columbia Task Force that served as the interface between NASA and the Columbia Accident Investigation Board. John F. Muratore is named Manager, Systems Integration Office. He most recently was Assistant to the Director of Engineering at JSC. Parsons replaced Ron Dittmore as Space Shuttle Program Manager last month. Web posted. (2003). [Shuttle program announces personnel changes [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, July 2].]

July 3: The second of two Mars Exploration Rovers, Opportunity, is rescheduled for launch on Sunday, July 6 at 10:43:16 p.m. EDT. Liftoff will occur aboard the Boeing Delta II Heavy launch vehicle from Pad B at Space Launch Complex 17 on Cape Canaveral Air Force Station. A second launch opportunity exists at 11:26:02 p.m. EDT, if necessary. Should launch be delayed by 24 hours, two launch times are also available on Monday at 10:35:23 p.m. and 11:18:15 p.m. EDT. The window of the planetary launch period extends through July 15. Opportunity will reach Mars on Jan. 25, 2004. ["Opportunity" Mars Exploration Rover Targeted for Launch July 6," **KSC News Release #55-03**, July 3, 2003.]

July 5: The launch of the MER-B Mars Exploration Rover "Opportunity" aboard a Boeing Delta II rocket has been postponed an additional 24 hours. The delay is due to the failure of a battery cell associated with a component of the launch vehicle's flight termination system. The battery must be removed and replaced. Launch is now targeted for no earlier than Monday, July 7. The two launch times available are 10:35:23 and 11:18:15 p.m. EDT. The forecast calls for a 30% chance of not meeting the launch weather criteria on

Monday evening. ["Launch of Opportunity" aboard Delta II postponed until July 7," **KSC News Release #56-03**, July 5, 2003.]

July 7: Fueled and ready to fly, the Rainbow 1 direct-to-home TV broadcasting satellite was delivered to Lockheed Martin's Atlas 5 assembly building and mounted atop its rocket launcher today for next week's liftoff from Cape Canaveral's Launch Complex 41. The third Atlas 5 rocket will carry the 4,328 kg spacecraft into orbit July 17 during a launch window of 7:20 to 9 p.m. EDT. Built by Lockheed Martin for Cablevision, the Rainbow 1 satellite will be operated in geostationary orbit to provide standard and high definition television programming to homes outfitted with an 18-inch rooftop dish. Web posted. (2003). [Atlas 5 fitted with a Rainbow [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, July 7].]

◆ The launch of the MER-B Mars Exploration Rover "Opportunity" aboard a Boeing Delta II rocket has been postponed an additional 24 hours. The delay is due to the failure of a battery cell associated with a component of the launch vehicle's flight termination system. The battery must be removed and replaced. Launch is now targeted for no earlier than Monday, July 7. The two launch times available are 10:35:23 and 11:18:15 p.m. EDT. The forecast calls for a 30% chance of not meeting the launch weather criteria on Monday evening. ["Newly Launched 'Opportunity' Follows Mars-Bound 'Spirit'," **NASA News Release #2003-095**, July 7, 2003.]

July 8: Technology and weather finally cooperated at the same time late Monday, allowing NASA at long last to send the Mars Rover Opportunity on its way to the Red Planet. Riding atop the first-ever Delta 2 Heavy rocket, Opportunity was sent safely speeding on a path that would have it escape Earth's gravity and travel seven months to reach the Martian surface. Opportunity is joining its twin, the Mars Rover Spirit launched June 10, on an \$800 million mission to learn more about when water might have flowed on Mars. Both probes are targeted to land in January. Only three of humanity's nine landing attempts at the Red Planet have succeeded, said Ed Weiler, NASA's space science chief in Washington, D.C. Web posted. (2003). [Mars rover Opportunity finally launched to Red Planet [Online]. Available WWW: <http://www.space.com/> [2003, July 8].]

◆ A foam projectile fired at the leading edge of a space shuttle's wing Monday all but destroyed a piece of its thermal armor, blasting a 16-inch hole in the material and providing dramatic evidence of what doomed Columbia. "We have found the smoking gun," said Scott Hubbard, the member of the Columbia Accident Investigation Board who oversaw the test. The test, which fired a 1.67-pound chunk of foam out of a nitrogen-powered cannon at about 500 mph, was aimed at the same spot where insulation that broke off Columbia's external fuel tank smashed into its left wing during its Jan. 16 launch. Columbia disintegrated over Texas on Feb. 1, destroyed -- investigators had theorized -- when superheated gases burned through the aluminum frame of the breached wing. The crew of seven was killed. But until Monday's foam shoot, at the Southwest Research Institute, there had been no convincing evidence that an insulation material not much denser than a Styrofoam beer cooler could breach the reinforced carbon-carbon that protects a wing's leading edge. "I felt surprised at how it appeared, such a dramatic punch-through," Hubbard said. "But it is the kind of damage, type of damage, that must have occurred to bring down the orbiter." The circular hole of about 256 square inches punched by the chunk of test foam brought hoots and gasps of "Wow!" from technicians and other onlookers. Six previous tests had produced far less damage, though one had cracked the protective carbon coating, and another had produced a dime-sized crack along a seal that connects two of the panels. Web posted. (2003). [Shuttle test reveals 'the smoking gun' [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, July 8].]

July 9: The space shuttle Columbia was not the first to have superheated gas invade its left wing on re-entering Earth's atmosphere, according to documents released by NASA. In 2000, the documents show, the shuttle Atlantis went into orbit with a quarter-inch breach in the wing's leading edge, allowing blowtorch-hot plasma into the wing on re-entry. But unlike the accident that destroyed the Columbia on Feb. 1 and killed its crew of seven, the incident resulted in only minor damage, leaving the wing's inner structure intact. The documents, which were released by the National Aeronautics and Space Administration under a Freedom of Information Act request, were first described yesterday by The Associated Press. They say the gap in the leading edge of the Atlantis wing was created because workers installed insulation improperly

during an overhaul in Palmdale, Calif., in 1997. The piece of gap-filling insulation was "folded up and pushed away" from the gap it was supposed to fill, leaving the cavity behind it exposed. Responding to the documents, an expert not involved in the Columbia investigation said yesterday that the Atlantis incident should have put NASA on high alert about wing damage. "That says they had fair warning and ignored it," said the expert, Paul A. Czysz, a professor emeritus at Parks College of Engineering and Aviation at St. Louis University and a longtime consultant to the space agency. As it happens, the Atlantis wing that sustained the quarter-inch breach was the same one that contributed a panel from its leading edge to a pivotal test in the investigation of the loss of the Columbia. In that test, done on Monday at the Southwest Research Institute in San Antonio, a chunk of insulating foam was fired at the panel, opening a gaping hole of 16 by 16 inches. Members of the independent board investigating the Columbia accident say the test validated their theory that foam shed on liftoff damaged the wing in a way that led to the loss of the shuttle and its crew on re-entry. In the Atlantis's 2000 mission, according to the NASA in-flight anomaly report, the much smaller gap caused a "substantial flow path" of plasma past the protective leading edge panels. The report found that "attaching hardware shows various signs of overheating," but that "the fittings do not exhibit any signs of melting or distortion." A NASA spokesman, Allard Beutel, said the only damage discovered by NASA after the flight was to the piece of insulation itself. "The only component that needed to be replaced was the butterfly gap filler seal that was installed improperly in the first place," Mr. Beutel said. The entire shuttle fleet was inspected for similar problems, and workers received new training in installing the part "to make sure that it never happened again," Mr. Beutel said. Web posted. (2003). [Earlier shuttle flight has gas enter wing on return [Online]. Available WWW: <http://www.nytimes.com/> [2003, July 9].]

July 10: The NASA spacecraft designed to test two important predictions of Albert Einstein's Theory of General Relativity was shipped yesterday from the Lockheed Martin Space Systems Facility in Sunnyvale, Calif., to the launch site at Vandenberg Air Force Base, Calif., after completing environmental testing. NASA's Gravity Probe B mission, also known as GP-B, will use four ultra-precise gyroscopes to test Einstein's theory that space and time are distorted by the presence of massive objects. To accomplish this, the mission will measure two factors -- how space and time are warped by the presence of the Earth, and how the Earth's rotation drags space-time around with it. Stanford University in Stanford, Calif., and Lockheed Martin performed the testing. Shipped by road transport, the vehicle arrived July 10 at Vandenberg for pre-launch operations in anticipation of a launch in late 2003. ["Spacecraft for NASA Mission to test Einstein's Theory Arrives at Vandenberg Air Force Base Launch Site," **NASA News Release #59-03**, July 11, 2003]

July 11: The shuttle program has seen little cost savings even though the remaining three orbiters have been idle since the Feb. 1 Columbia disaster, a NASA spokeswoman said Friday. "There are no large-scale savings because of the grounding of the fleet," said Melissa Motichuk, a NASA spokeswoman. "People are still working and producing what they produce." The only savings agency managers could point to was about \$30 million that wasn't spent on rocket fuel and personnel overtime for the two shuttle flights canceled after the Columbia accident. Other than that, shuttle spending has continued at a steady rate, Motichuk said. Lawmakers and others had speculated for months that the idled shuttle fleet might leave NASA with a substantial amount of unspent money at the end the fiscal year. There was an expectation, particularly in Congress, that one fewer orbiter to service and two canceled missions would produce a surplus. NASA flew three missions during the current fiscal year. In recent years, the agency has flown between four and seven missions a year with only modest differences in the shuttle program's annual costs. In the past, NASA officials have said the marginal cost of a typical shuttle mission is \$100 million. Much of the program's cost is dominated by personnel, most of whom NASA and its shuttle contractors have kept on the payroll despite the accident. Web posted. (2003). [Grounded shuttle fleet saves agency little [Online]. Available WWW: <http://www.floridatoday.com/> [2003, July 11].]

◆ The Columbia Accident Investigation Board members are sifting through stacks of investigative material in a push to complete by late August a report on the causes of the shuttle disaster, the chairman said today. "The board is involved almost exclusively with writing the report now," said retired Adm. Harold Gehman Jr. He said just about all of the investigative activities are now complete and the 13-member board is divided into groups that are writing chapters of the report. The report, which also will recommend ways in which NASA can make shuttle flight safe again, is expected to reach more than 100

pages. It will focus on the root causes of the Feb. 1 accident that killed seven astronauts. Participants at a news conference today said the report will include a detailed analysis of a test that one member called the "smoking gun" cause of the accident. Air Force Gen. Duane Deal said the report also will examine NASA's quality assurance programs and analyze how the agency allowed "potentially deadly events to become acceptable." He said there were at least seven incidents in earlier flights in which foam insulation smashed into the shuttle during launch, yet NASA continued to fly the craft without fixing the problem. Deal said NASA needs to treat the shuttle as a test vehicle instead of an operational spacecraft. Web posted. (2003). [Shuttle should be considered a test vehicle, board member says [Online]. Available WWW: <http://www.floridatoday.com/> [2003, July 11].]

July 12: The size of the hole in the space shuttle Columbia's left wing was large enough that a spacewalking astronaut or satellite cameras might have seen it, investigators said Friday. The size of the breach -- thought to be roughly 6 to 10 inches large -- is "absolutely" within the detection capability of the cameras on board military satellites, said retired Adm. Harold Gehman, the head of the independent panel probing the cause of the accident. Some engineers in the shuttle program wanted satellite images to get a better sense of the damage, but ultimately the request was never made. Gehman said that as the board hunkers down to finish its report, now expected late next month, its members consider NASA's management failures to be on equal footing with the foam as the cause of the disaster. "We've now decided that these things are equal," he said. "I believe the way the report's going to characterize these things is we have what we're now calling either a physical or mechanical failure, and then we have systemic failures." Armed with dramatic confirmation of the long-held theory that a chunk of foam that hit the shuttle caused enough damage to doom its fiery re-entry into the Earth's atmosphere, board members said they are working hard to connect the dots between NASA's technical problems, its management issues and the Feb. 1 accident. Investigators released a 189-page "working scenario" and said the National Aeronautics and Space Administration needs to regard the shuttle as the test vehicle that it is, rather than a spacecraft capable of routine flight. In a test on Monday, foam roughly the same size as the piece that hit Columbia 82 seconds into its Jan. 16 launch blasted a huge hole in one of the reinforced carbon-carbon panels that cover the shuttle's wings. Investigators think the actual hole was probably smaller. The dramatic results of the test validate the board's theory that the foam damage allowed a plume of superhot gas to penetrate the wing and destroy the orbiter during re-entry. But further examination of test film also has shed more light on what was picked up by radar floating away from Columbia on the second day of the mission. Board member Scott Hubbard, who oversaw the testing, said investigators now think the object was a piece of the RCC panel damaged by the foam strike. The test results also reignite the question of whether the NASA officials monitoring Columbia's last mission might have realized the extent of the damage had they ordered in-orbit photos or a spacewalk. "I don't think astronauts on a spacewalk could have any problem seeing this hole," Hubbard said Friday. NASA managers, however, accepted an analysis done by shuttle contractors that the lightweight foam had not done enough damage to endanger the orbiter or the crew. So they did not pursue satellite photos and never sent an astronaut outside Columbia to check it out. Gehman cautioned that it is almost impossible to know whether NASA managers would have spotted the fatal damage if they had sought images of the wing. Several people involved in the discussions over the imagery were reassigned to other jobs within the agency last week. Web posted. (2003). [Photo might have shown hole [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, July 12].]

◆ Columbia accident investigators have pinpointed a handful of dangers within shuttle systems and have urged NASA to fix them before returning the three remaining orbiters to flight. "We have a responsibility to provide NASA with indications of what we think the next mishap could be . . . where they need to pay attention," said Air Force Maj. Gen. John Barry, a member of the Columbia Accident Investigation Board. Among the hazards noted by the board: *An inadequate design in a device used to catch heavy metal debris from explosive bolts that separate the shuttle's twin solid rocket boosters from its external fuel tank about two minutes into flight. Tests carried out for the board showed that the so-called "bolt catchers" are weaker than engineers had thought. The concern is that they could break apart and shower parts of the shuttle's fragile thermal-protection system with potentially deadly debris. *Problems with detonation signals to huge, explosive nut-and-bolt assemblies used to hold shuttle boosters on a mobile launcher platform before liftoff. Each of the 149-foot boosters is held down on the platform by four of the assemblies. Signals sent to the assemblies make them blast them apart during booster ignition. That lets the shuttle to lift off its pad. During an October 2002 launch, one of two duplicate signals that trigger the

release system failed. The second signal worked, and the shuttle safely launched. But a failure of both signals could have resulted in serious booster damage and potentially, a launch disaster. *Potential flaws in large bearings in shuttle propellant lines that allow the pipes to flex slightly, but not collapse, when subjected to launch vibrations. Engineers found a crack in one of the plum-sized bearings in December while inspecting a 17-inch-diameter liquid oxygen feed line in shuttle Discovery. A bearing failure in flight could produce debris that could get swept into a main engine, triggering a shutdown or explosion. Web posted. (2003). [Board identifies dangers, key fixes. [Online]. Available WWW: <http://www.floridatoday.com/> [2003, July 12].]

July 14: William F. Readdy, Associate Administrator for Space Flight at NASA Headquarters in Washington, today named Woodrow Whitlow, Jr., Ph.D., as the new Deputy Director of the agency's Kennedy Space Center (KSC), Fla., effective August 31. Whitlow will succeed James W. Kennedy, who becomes Center Director on August 10. "Dr. Whitlow is a tremendous addition to our KSC leadership," said NASA Administrator Sean O'Keefe. "Woodrow will help maintain the Center's unsurpassed performance as the world leader acquiring, preparing, managing and launching key payloads and expendable vehicles. He is an experienced, proven performer and leader with the right technical expertise to help NASA successfully return to flight, while successfully conducting other launch, science operations, and payload processing" Administrator O'Keefe added. As Director of Research and Technology at NASA's Glenn Research Center (GRC), Cleveland, since 1998, Whitlow led a staff of more than 470 scientists and engineers conducting research in high-temperature materials, aerospace power, propulsion systems, structures, and acoustics. Whitlow planned and directed GRC research and technology development efforts to meet NASA programmatic commitments for advances in space power, space and aeronautics propulsion, and space communications. ["Whitlow Named Kennedy Space Center Deputy Director," **NASA News Release #03-238**, July 14, 2003.]

July 16: House lawmakers adopted a go-slow approach Tuesday regarding NASA's spending priorities in the wake of the Columbia shuttle tragedy. With little discussion, members of an appropriations subcommittee quickly approved a \$15.3 billion budget for NASA in the fiscal year that begins Oct. 1. That is \$201 million more than the current year's spending level. Lawmakers postponed action on the difficult question of how to pay for hardware and management changes that will be necessary to return the remaining three space shuttles to flight. "We're going to have to put more money into this bill for NASA or adopt a supplemental spending bill in the fall," said Rep. Dave Weldon, R-Melbourne. Weldon sits on the House panel that sets spending levels for the space agency and other federal programs, including veterans, housing and the environment. Panel members also discussed the uncertain future of the U.S. space program and the funds that will be needed to comply with a long list of recommendations from the Columbia Accident Investigation Board. Tuesday's voice vote in the appropriations subcommittee sends the annual spending bill - one of 13 - to the House Appropriations Committee, where it is expected to pass before July 25. Senate appropriators have not yet unveiled their budget plans for NASA. Space agency officials have yet to define how much money will be necessary to make the shuttle fleet safe to fly again. . Web posted. (2003). [House panel OKs NASA budget, goes slow on shuttle funding [Online]. Available WWW: <http://www.floridatoday.com/> [2003, July 16].]

◆ National Aeronautics and Space Administration officials today named Michael E. Wetmore as the new Launch Integration Manager for the Space Shuttle program. He assumes the responsibilities of this role effective immediately. "Mike's technical expertise and high level of energy will be a great asset to the Shuttle program," said KSC Director Roy Bridges. "His leadership abilities will be an enormous benefit to the Agency helping to develop and implement NASA's plans for the Shuttle's return to flight." Wetmore is responsible for all aspects of Space Shuttle preparation, launch, and return of the orbiter to KSC following flight. Wetmore succeeds N. Wayne Hale, who was recently assigned as deputy manager, Space Shuttle program. Until a replacement is named, Wetmore will also maintain his current responsibilities as acting director of Shuttle processing at KSC. ["Wetmore Named Launch Integration Manager for Shuttle Program," **NASA News Release #60-03**, July 16, 2003.]

◆ NASA is studying possible changes to the space shuttle's flight paths during landing to minimize risk to people on the ground. A July 16 internal National Aeronautics and Space Administration document indicates the space agency is, for the first time, assessing the risk associated with shuttle landings at

Kennedy Space Center, Edwards Air Force Base in Southern California's Mojave Desert and New Mexico's White Sands Missile Range. The most likely result could be to restrict certain landing approaches to the shuttle's backup runway at Edwards. According to the document, public risk is by far the greatest for shuttle landings at Edwards that fly over the densely populated Los Angeles basin. Additional options being analyzed include eliminating landing approaches over other heavily populated areas, modifying the way the shuttle maneuvers during re-entry and possibly using alternate runways at California's Vandenberg Air Force Base and foreign sites. While some of those alternatives are considered long shots, any changes would be implemented before the fleet's three remaining orbiters return to flight next year. "Assessing public risk is a new requirement to the shuttle program," the NASA document says. "NASA should evaluate risk, select criteria and alter flight rules to manage risk." The goal is to expose as few people as possible to the risk of falling debris in case another shuttle suffers a catastrophe during landing like Columbia's breakup over Texas on Feb. 1. No one on the ground was injured. But more than 42 tons of shuttle fragments -- some weighing hundreds of pounds -- rained on a 2,400-square-mile corridor in mostly rural east-central Texas and western Louisiana. Even so, the Columbia Accident Investigation Board doesn't plan to press NASA for changes in landing procedures. A July 8 presentation on the Columbia accident and debris hazards done for the board by ACTA Inc., a risk-management and -analysis company, concluded: "A lack of casualties was the expected event. We think something NASA should include in planning is risk assessment of debris," board spokeswoman Laura Brown said, "but it will not be a major part of the board's report." ["NASA might revise shuttle flight paths to curb risks," **Orlando Sentinel**, August 1, 2003, p A1 & A16.]

July 17: NASA inspectors charged with making sure space shuttles are safe to fly were forced to buy their own tools and prevented from making spot checks, a Columbia accident investigator says. The investigator, who spoke with The Associated Press in interviews over several days, said NASA's program that oversees shuttle inspections will "take a pretty big hit" in the Columbia accident report due out in late August. Air Force Brig. Gen. Duane Deal, one of 13 members of the board investigating the cause of the shuttle accident, says he obtained crucial information by offering confidentiality to the 72 NASA and contractor employees he interviewed over months. "They'd be fired" if their bosses found out what they confided, said Deal. "It is not an exaggeration." He said his findings seemed to indicate that some NASA managers were "perhaps out of touch with the realities of manned spaceflight" when it came to the level of shuttle inspections needed. Gehman says NASA must treat every shuttle launch like it's the first. Deal said that nearly 9 out of 10 workers interviewed said the investigation board should review the space agency's quality assurance program at Kennedy Space Center in Florida and other NASA installations. That unit provides oversight to ensure safe shuttle flight operations. He called the program "poor" because the number and kinds of inspections have been cut back. "There are some inspections that have been pulled out," he said. "It's almost universal opinion that we should be looking at these things because they are kind of final inspections that NASA, the government, the customer, should be laying their eyes on." Mike Rein, a NASA spokesman at Kennedy, declined to respond directly to Deal's assessments, but noted that ever since the accident, the space agency has been reviewing practices in all areas and making improvements where necessary. "We're working it hard and we think it's especially important in the area of safety," he said. Deal, who has taken part in about a dozen investigations into military aircraft and rocket accidents, said NASA quality assurance inspectors were not allowed to do everything in their job descriptions. For instance, he said, they were not allowed to do spot checks, "to just wander around and see what you can see." He blames the NASA hierarchy for this "fairly serious" problem. Bureaucracy also is the reason NASA quality assurance inspectors were denied the necessary tools to do their jobs, Deal said. "They were supposed to have a nine-time magnifier and they only had a three, and it was taking them months to get a nine-time magnifier, so they went down and bought one at Home Depot," he said. Other problems cited by workers who were interviewed at several NASA installations: NASA shuttle inspectors trained by the contractors they are supposed to monitor. Virtually everyone wanted more formal training, Deal said. NASA inspectors relying totally on a contractor database to track problem reports, because NASA had discontinued its own tracking systems. Hopelessly outdated test equipment that costs a lot to keep running and is not nearly as accurate as newer, digital systems. Deal, who has degrees in both physics and psychology, got his unusually candid look by asking almost every worker: If you were king or queen for a day, what would you change at NASA? What's been gnawing at you that you would try to improve right away? The interviews were usually held off space center property, sometimes in hotel rooms. The investigation board as a whole has done more than 260 interviews in its quest to find out what caused

Columbia to shatter over Texas in February and what caused shuttle managers to so readily discount the strike to the leading edge of the left wing by a chunk of fuel-tank foam insulation during liftoff. Web posted. (2003). [NASA inspectors had to buy own tools [Online]. Available WWW: <http://www.floridatoday.com/> [2003, July 17].]

◆ Kennedy Space Center has a new manager in charge of preparing and launching space shuttles and bringing them home. On Wednesday, NASA named Mike Wetmore, who took over shuttle processing in November, to the job of launch integration manager. He replaces Wayne Hale, who was recently appointed deputy manager of the shuttle program at Johnson Space Center. Wetmore comes into a job that has seen a lot of upheaval in the past year. Hale started the job Feb. 1, the day shuttle Columbia was destroyed. Before that, Linda Ham -- who headed the mission management team for Columbia's flight -- was acting launch integration manager, on the heels of Jim Halsell, an astronaut who left the job to train for another shuttle mission. Web posted. (2003). [KSC names new shuttle launch integration boss [Online]. Available WWW: <http://www.floridatoday.com/> [2003, July 17].]

July 18: NASA managers have set a target date for launching the next space shuttle no earlier than March, and that date could slide even more. At a meeting this week, NASA managers recommended shifting an unofficial timetable from Dec. 18 to no earlier than March 11. And even the new launch target is more for planning purposes than an indication of when the next shuttle may actually fly, NASA officials said. NASA still is waiting for the results of the Columbia accident investigation, and a host of factors including tricky hardware fixes to make the shuttles safer, new launch requirements and an inspection that needs to be done on Atlantis -- the next orbiter in line -- make circling any date on a calendar very difficult. "The fact that NASA talks about a target date does not necessarily mean that's a projected launch date," agency spokesman Bob Jacobs said. "Because everything is going to be predicated on what comes out of the [Columbia Accident Investigation Board]." The head of that panel, retired Adm. Harold Gehman, has said that the board's report, expected to be released late next month, should not contain any surprises for NASA. The board has already telegraphed, either informally or through interim recommendations to the space agency, the most challenging changes that are needed before the next launch. NASA is close to a solution for the so-called bipod ramp on the shuttle's massive external fuel tank. That's the area where the shuttle connects to the tank and where the 1.67-pound chunk of foam came loose and struck Columbia's left wing on liftoff. Investigators think that strike caused the damage that allowed superhot gases to penetrate Columbia's wing during re-entry, dooming the seven-member crew. But the board's mandate that the Space agency come up with a plan to repair the thermal tiles and reinforced carbon-carbon panels that protect the shuttle from the searing heat of re-entry, however, is almost certain to take significantly longer. Then there are the hurdles posed by the new requirement that the shuttle only be launched in daylight, so that cameras can film and document any future damage to a shuttle during liftoff. NASA also wants the separation of the external tank from the shuttle, roughly eight minutes into launch, to occur in daylight, further restricting the dates and times for scheduling a liftoff. In addition, Atlantis needs a wiring inspection before its next flight, and program managers are still wrestling with whether to do a very detailed inspection -- which could pose a schedule problem -- or a slightly less comprehensive version. All these variables are part of a mix that includes pressure to support the international space station, questions from Congress once the report is released and the attention of a public eager to close the book on the Feb. 1 loss of Columbia and her crew. Web posted. (2003). [Shuttle's next launch date remains far from certain [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, July 20].]

July 20: NASA officials are delicately seeking advice about what to do with the 84,000 shattered pieces from Columbia, cautiously broaching the idea of putting some shuttle parts on display. There is no precedent for publicly displaying disasters from the U.S. space program. And in the case of Columbia, there are mixed feelings among the survivors of the astronauts. "It touches everybody who sees it," said Jonathan Clark, husband of astronaut Laurel Clark. "It has a tremendous impact on you. It makes you realize the importance of space exploration." Kirstie McCool Chadwick, sister of pilot Willie McCool, said she supports the debris being used for research, but "I don't know what the purpose of displaying it in public would be. I'm not sure that it makes sense to me." Officials from several cities have written NASA asking for pieces of Columbia for their own memorials, and curators at the Smithsonian National Air and Museum in Washington have been holding informal discussions with the space agency. A decision may come by the end of this month. For now, the debris is spread on the floor of a hangar at the Kennedy space

Center. It will remain there until the end of August when the Columbia Accident Investigation Board is expected to issue its report on the cause of the disaster. The shuttle broke apart over Texas on Feb. 1, killing all seven astronauts. Curators at the Smithsonian museum plan to review the debris to see what pieces they may be interested in acquiring. "Initially, we wouldn't have plans for it to go on display, only to collect it for preservation as historic artifact," said Valerie Neal, a space history curator at the museum. "What we might do in the future, I just don't know." ["NASA debates Columbia debris displays," **Florida Today**, July 21, 2003, p 6A.]

◆ From the very beginning, NASA is designing its next spacecraft with a far better crew escape system than is available on the space shuttles. The Orbital Space Plane, the astronaut ferry NASA hopes to be flying before the end of the decade, will have to meet guidelines requiring an escape system to get the people aboard safely away from an exploding rocket or other accident scenario during launch. The space plane is envisioned as a crew-only transport to carry astronauts to and from the International Space Station. One would remain docked at the station as a lifeboat for the station's permanent crew – a role now filled by Russia's Soyuz capsules. While NASA is speeding up the space plane project in the wake of the Columbia disaster, key decisions have yet to be made – most notably whether the ship will be winged like the shuttles or more like the capsules of old. NASA and the contractors working on the Orbital Space Plane concepts are focusing escape efforts mostly on launch. ["Better escape system assured," **Florida Today**, July 21, 2003, p 7A.]

July 22: The space-shuttle managers who oversaw Columbia's final mission never seriously considered the possibility that foam debris could harm the ship, according to records of their meetings. Transcripts of the flight's five Mission Management Team, or MMT, meetings obtained by the Orlando Sentinel show officials mentioned the foam strike during only three. Each time, they skimmed over concerns about the debris strike during launch that led to the shuttle's breakup over Texas on Feb. 1. Managers were quick to label the impact of a piece of insulating foam from Columbia's external fuel tank on the ship's left wing as "no safety of flight issue" despite uncertainty about the size and location of the hit. The transcripts also suggest that managers were confident foam never could seriously damage the shuttle and they told Columbia's seven astronauts about the impact a week after launch only because the press learned of it. "Was the MMT open-minded and asking for dissenting views?" said a source close to the investigation, who spoke on condition his name not be used. "They did not do that. But they didn't do that because they had a strong belief that overpowered any proper management techniques." What managers didn't know was that the chunk of foam was perhaps the largest ever to come off the tank and that it likely knocked a gaping hole in a reinforced carbon-carbon, or RCC, panel on the left wing's leading edge. The breach allowed blowtorch-like gases to eat away Columbia's wing during landing. The transcripts offer further evidence of the Columbia Accident Investigation Board's contention that organizational breakdowns were as serious as any technical issues involved in the shuttle disaster. The board is expected to issue a recommendation for significant changes in how the MMT conducts business when the group's final report is released in August. Web posted. (2003). [Foam damage not seriously considered [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, July 22].]

◆ Spacecraft functional testing is under way this week for the SCISAT-1 launch from Vandenberg AFB. The solar arrays were mated to the spacecraft on July 11. The communications systems were also successfully checked out. The spacecraft transponder is powered on for run time as part of routine test and evaluation. SCISAT will be mated to the Pegasus launch vehicle on July 25. Fairing installation activities begin Aug. 2. Installation onto the Pegasus transporter is scheduled for Aug. 6 followed by rollout to the hot pad and mating to the L-1011 carrier aircraft on Aug. 9. SCISAT-1 weighs approximately 330 pounds and will be placed in a 400-mile-high polar orbit to investigate processes that control the distribution of ozone in the upper atmosphere. The scientific mission of SCISAT-1 is to measure and understand the chemical processes that control the distribution of ozone in the Earth's atmosphere, particularly at high altitudes. The data from the satellite will provide Canadian and international scientists with improved measurements relating to global ozone processes and help policymakers assess existing environmental policy and develop protective measures for improving the health of our atmosphere, preventing further ozone depletion. The mission is designed to last two years. ["SCISAT-1 mission to measure chemical processes controlling ozone on Earth," **KSC Countdown**, July 22, 2003.]

July 23: A routine hearing in the normally placid House Science Committee evolved into a debate Tuesday over when and how the panel will address safety concerns at NASA in the wake of the space shuttle Columbia accident. Democrats on the committee questioned whether there will be an opportunity this fall to deal with issues raised by the Feb. 1 disaster. They pressed the panel's chairman to attach safety-oriented provisions onto a bill aimed at increasing the agency's ability to hire and retain workers. The Democrats lost almost all the battles -- on votes that broke along party lines -- but U.S. Rep. Sherwood Boehlert, the New York Republican who heads the committee, promised an airing of NASA's problems. Boehlert said the committee will spend a good chunk of this fall, and probably early next year, examining the findings of the independent board investigating the accident. That panel, led by retired Adm. Harold Gehman, is expected to deliver a report late next month that will lay bare a safety system that failed badly. Boehlert said he will take the committee's oversight duties "darn seriously" and that he expects full cooperation from the National Aeronautics and Space Administration as it works to return the remaining three space shuttles to flight. ["Committee argues about NASA safety," **Orlando Sentinel**, July 23, 2003, p A7.]

◆ Engineers' concerns that shuttle Columbia suffered serious damage during liftoff never reached top mission managers, according to three NASA officials who spoke at a tearful, emotion-charged news conference at Johnson Space Center on Tuesday. The officials -- former mission management team chairwoman Linda Ham, mission operations representative Phil Engelauf and flight director LeRoy Cain -- said they took at face value a damage assessment that concluded there was no safety risk from a piece of foam insulation that broke off Columbia's external fuel tank and struck the ship's left wing. "Based on the information that I had at the time that I made those decisions in the MMT [mission management team meeting] and information that we as a team had at the time, we were really doing the best that we could," Ham said in her first public appearance since the accident. "I think we all take some personal responsibility for this, and I certainly feel accountable for the MMT." As chairwoman of the MMT, Ham, in particular, has been singled out for criticism of how shuttle officials had handled the issue. Transcripts and audiotapes of the five management team meetings held during Columbia's flight -- released Tuesday by NASA -- showed managers never really considered the foam a problem and dismissed the issue after little discussion. In fact, the foam knocked a hole in the leading edge of Columbia's left wing that led to the shuttle's breakup over central Texas on Feb. 1. Some engineers communicated concerns among themselves that Columbia was seriously damaged. The managers, however, contended they never heard those concerns despite a system that encourages workers to come forward. ["Flight boss didn't hear of foam fears," **Orlando Sentinel**, July 23, 2003, p A1 & A7.]

July 24: With the release of the report on the Columbia accident investigation just weeks away, NASA Administrator Sean O'Keefe told employees Wednesday to brace for heavy criticism, but said the opportunity is there for the agency to emerge reinvigorated. "It's going to be a challenge, no doubt about it," O'Keefe said in response to an employee's question about the coming weeks. O'Keefe, speaking at Goddard Space Flight Center in Greenbelt, Md., said he expects the Columbia Accident Investigation Board to offer sweeping criticism of the agency when it delivers its report late next month. But NASA needs to accept those findings and concentrate on how to fix the problems, he said, not argue the details. "We're going to get hammered, but we're going to come out stronger. That has to be our mind-set -- if we take it personally and are defensive about it, it's going to be really, really difficult to work with," O'Keefe said. "Our history has always been that we confront those problems; we confront those challenges." The agency chief's comments echoed those made in a letter sent earlier this month by William Readdy, a former astronaut and the National Aeronautics and Space Administration's top spaceflight official. In that letter to the group trying to return the three remaining shuttles to flight, Readdy noted "We have a very long, tortuous, uphill climb ahead of us" but expressed confidence in the team. Both men's comments seem aimed at boosting agency morale in the last agonizing weeks before the board's report is released. O'Keefe updated employees on the work being done to return the shuttles to flight, sounding a note of optimism even as he said the process will not be governed by the calendar. With the cooperation of every NASA employee, he said, shuttle Atlantis could be headed for the international space station next spring. ["NASA must prepare for pounding," **Orlando Sentinel**, July 24, 2003, p A12.]

◆ Workers recently installed two new panels bearing the Columbia astronauts' names into the Space Mirror Memorial, a 42-foot-high and 50-foot-wide wall near the entrance to the Kennedy Space Center

Visitor Complex. A black veil will cover the 500-pound panels until they are unveiled at an official ceremony involving the astronauts' families in late October. When uncovered, the names will join those of 17 other fallen astronauts on the wall. Illuminated by the sun's rays during the day and by powerful lights at night, the names will be visible continuously. The Astronauts Memorial Foundation created the Space Mirror Memorial. The nonprofit group was formed after the Challenger accident in 1986 to honor all U.S. astronauts who lost their lives on missions or while training for missions. The foundation also operates the Center for Space Education at the KSC Visitor Complex as a "living memorial" to the astronauts. The Space Mirror Memorial, dedicated in 1991 by former Vice President Dan Quayle, was designated a national memorial by Congress and former President George H.W. Bush. The Columbia crew that perished during the re-entry Feb. 1 were David Brown, Rick Husband, Laurel Clark, Kalpana Chawla, Michael Anderson, William McCool and Israeli astronaut Ilan Ramon. ["Global effort hastens creation of Columbia crew memorial," **Florida Today**, July 24, 2003, p 1A & 3A.]

◆ NASA officials recently named James E. Hattaway Jr. as the new associate director of Kennedy Space Center (KSC). He assumes the responsibilities of this role immediately. "I have always been proud to be a part of NASA and the KSC team," said Hattaway. "Being selected for this position is truly an honor. I am excited about this opportunity and look forward to continuing to work with the 45th Space Wing and the NASA contractor community as we return to flight, complete assembly of the Space Station, move forward with the Orbital Space Plane, and continue our Expendable Launch Vehicle Program." In this capacity, Hattaway will provide executive oversight of institutional operations at KSC. This will include integrating and deciding cross-organizational institutional issues in matters related to financial management, work force planning, infrastructure management and information technology. In addition, Hattaway will provide oversight for NASA Exchange operations, and he will serve as KSC's point of contact for Agency initiatives such as implementation of the President's Management Agenda, Freedom to Manage, Competitive Sourcing and the NASA Shared Services Center. ["James E. Hattaway Named KSC Associate Director," **KSC News Release # 64-03**, July 24, 2003.]

◆ Air Force officials announced July 24 that the Boeing Company has committed serious violations of federal law. This determination is based on the service's review into allegations of wrongdoing by Boeing during the 1998 evolved expendable launch vehicle source selection. As a result, the Air Force will suspend three Boeing Integrated Defense System business units and three former Boeing employees from eligibility for new government contracts. The suspensions are issued against the Boeing Company's Launch Systems, Boeing Launch Services and Delta Program business units as they existed in the Boeing organizational structure as of July 21. This suspension will apply to these business units regardless of where they fall in any Boeing reorganization. Web posted. (2003). [US Air Force announces Boeing EELV inquiry results [Online]. Available WWW: <http://www.spaceref.com/> [2003, July 28].]

July 25: House members, who still don't know what will be necessary to get the grounded space shuttle fleet flying again, passed legislation Friday that would provide a \$15.5 billion budget for NASA in the fiscal year that begins Oct. 1. That represents a proposed increase of \$201 million over NASA's current-year budget. The Senate has yet to begin work on its NASA appropriation. In separate legislation passed Friday, the House approved a measure that would give NASA \$50 million for the investigation into the Columbia shuttle accident. The House also adopted an amendment by Rep. Ralph Hall, D-Texas, that would earmark \$15 million to study crew escape pods for the shuttle. Also Friday, Rep. Sherwood Boehlert, R-N.Y., chairman of the House Science Committee, said he plans to hold hearings in to the Columbia investigation findings immediately after Congress returns from its August recess. ["House Oks \$15.5 billion 'status quo' budget for NASA," **Florida Today**, July 26, 2003, p 8A.]

July 27: The space shuttle engineers who desperately wanted zoom-in satellite pictures of the damaged Columbia in orbit never spoke up at key meetings and never told the manager in charge of the flight. They were too uncomfortable. Too afraid. Whatever the reason for the chilling silence, NASA chief Sean O'Keefe is promising dramatic change. He told employees this past week he is committed to "creating an atmosphere in which we're all encouraged to raise our hand and say something's not right or something doesn't look safe. We all have a responsibility," he said, "to redouble our efforts to create that atmosphere." For starters, employees will be able to go to the NASA Web site and "file anything anybody

sees as being off,” O’Keefe said. Web posted. (2003). [NASA promises to break culture of silence [Online]. Available WWW: <http://www.cnn.com/> [2003, July 27].]

July 28: At Vandenberg Air Force Base, Calif., the SCISAT spacecraft was mated to the Pegasus launch vehicle July 28. The payload fairing was scheduled for installation Aug. 4. Installation onto the Pegasus transporter is scheduled for Aug. 6 followed by rollout to the hot pad and mating to the L-1011 carrier aircraft on Aug. 9. SCISAT-1 weighs approximately 330 pounds and will be placed in a 400-mile-high polar orbit at an inclination of 73.9 degrees. [““CISAT mission launching Aug. 12 to collect ozone data,”” **KSC Countdown**, August 5, 2003.]

◆ Kennedy Space Center has completed the construction of two new security gates on State Road 3 and State Road 405, complementing the opening of the Space Commerce Park and a new roadway. The new roadway, named Space Commerce Way, will provide an alternate route for the general public between Titusville and Merritt Island. The roadway will be accessible by the general public 24 hours a day. The new gates and roadway are scheduled to open Aug. 1. The new roadway will also serve north Merritt Island and other barrier island residents as part of the hurricane evacuation route. [“KSC to activate new security gates and open new roadway, Space Commerce Way,” **KSC News Release #65-03**, July 28, 2003.]

◆ Two-thirds of Americans say the space shuttle should continue to fly despite two disastrous accidents, but enthusiasm for putting civilians aboard is declining, an Associated Press poll finds. The strong support continues even after the fiery disintegration of Columbia in February and the grounding of the remaining shuttles during an investigation into the cause of the accident that killed the crew of seven astronauts. The poll of 1,034 adults was taken July 11-15 and carries an error margin of plus or minus 3 percentage points. Web posted. (2003). [Poll: Support for Space Program Steady [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, July 28].]

July 29: NASA has chosen the Atlas V expendable launch vehicle, provided by Lockheed Martin Commercial Launch Services Inc., as the launch system for the Pluto New Horizons mission. The Pluto mission is scheduled for launch in January 2006. The mission is a scientific investigation to obtain the first reconnaissance of Pluto–Charon, a binary planet system. New Horizons would seek to answer key scientific questions regarding the surfaces, atmospheres, interiors, and space environments of Pluto and Charon using imaging, visible and infrared spectral mapping, ultraviolet spectroscopy, radio science, and in-situ plasma sensors. [“Mission to Pluto to scout surface, atmosphere,” **KSC Countdown**, July 29, 2003.]

◆ July 29 marked the 1000th day of human occupancy of the International Space Station. With the arrival of the Expedition 1 crew on Nov. 2, 2000, international crews began living and working on the ISS. The crew comprised Commander Bill Shepherd, Soyuz Commander Yuri Gidzenko and Flight Engineer Sergei Krikalev. Currently a two-man crew occupies the Station: Commander and Russian cosmonaut Yuri Malenchenko and NASA/ International Space Station Science Officer Ed Lu. In October, veteran NASA astronaut Michael Foale and seasoned Russian cosmonaut Alexander Kaleri are set to be the eighth crew to live aboard the International Space Station. The International Space Station is now the size of a three-bedroom house and will grow even further in the years ahead in size and scientific research capability. [“One thousand days in space and counting,” **KSC Countdown**, July 31, 2003.]

July 30: JoAnn Morgan, director of External Relations and Business Development at Kennedy Space Center, announced her retirement from NASA, effective Aug. 3, 2003. Morgan’s career spans 45 years and includes a list of firsts at KSC, including her appointment as the first woman senior executive at the space center. She has been in leadership roles at KSC for the past 20 years. Her list of firsts also includes first woman in the Launch Control Center Firing Room during the Apollo program; first woman division chief; first woman to win a NASA medal; first woman senior executive at KSC; first woman associate director for KSC and first woman to act as deputy director of KSC. Additionally, Morgan was the first woman in NASA to win the coveted Sloan Fellowship. The Sloan Fellowship is one of the NASA fellowship programs and grants fellowships to MIT in Massachusetts and Stanford University, Calif., for graduate study. The program is international and includes students from government and industry in the United

States and abroad. "JoAnn's career is a model of success," said KSC Director Roy Bridges Jr. "She is the pioneer for all the female engineers at NASA. She is my hero, too. She has a passion for excellence that is rarely exceeded. She thinks 'out of the box' and makes things happen. What a joy to work with her!" Morgan entered the federal work force as a University of Florida student trainee with the Army Ballistic Missile Agency in 1958, and worked for NASA on the Mercury and Gemini programs. During her years in the Apollo, Skylab and Apollo-Soyuz programs, she was a key member of the KSC launch team. She then became one of the KSC team developing the Space Shuttle launch processing system central data subsystem, which was initially used for the first launch of the orbiter Columbia. Following this, she served in managerial positions including division chief and deputy director, Expendable Launch Vehicles; director of Payload Projects and Ground Operations; and director for Safety and Mission Assurance with overall responsibilities for the KSC safety, reliability, maintainability, quality and mission assurance programs. Morgan worked on teams at all the NASA centers and NASA Headquarters, including assignments at Marshall Space Flight Center, Huntsville, Ala., and Langley Research Center, Hampton, Va. During the early part of her career, she spent 15 years on launch teams as an engineering member in information systems, communications and instrumentation services. Prior to her appointment to the External Relations and Business Development directorate, she was the KSC associate director for Advanced Development and Shuttle Upgrades. In this capacity, she provided leadership for KSC's support to Shuttle flight systems upgrades and for creating a customer-driven environment and new opportunities for the KSC team to participate in cutting-edge technology development and application. During her career in the U.S. human space flight programs, Morgan has received many honors and awards, including an achievement award for her work during the activation of Apollo Launch Complex 39, four exceptional service medals, and two outstanding leadership medals. ["JoAnn Morgan to retire after 45-year career at the Cape," **KSC News Release #66-03**, July 30, 2003.]

◆ The risk of killing or injuring people on the ground in a Columbia-like accident is prompting NASA to consider changes in shuttle landing strategies. That could mean limiting landings at Kennedy Space Center and restricting shuttles from flying over densely populated cities during fiery atmospheric reentries. That, in turn, could lead to more shuttle landings at Edwards Air Force Base in California to minimize the public exposure to shuttle debris in the event of another accident. "Landing site selection and entry over-flight of population centers are topics we are going to discuss," said Wayne Hale, NASA's deputy shuttle program manager. Senior program managers are examining "whether there is some restriction that we think is prudent," he said. The potential changes are being considered in the wake of the Feb. 1 shuttle Columbia accident that killed seven astronauts. More than 40 tons of wreckage rained down on mostly rural parts of eastern Texas after the spaceship disintegrated 38 miles above Earth, spurring a spate of studies into the risks posed to the public during shuttle reentries. Hundreds of thousands of people in Dallas and New Orleans would have been exposed to falling wreckage had Columbia broke up a little earlier or later than it did, an Air Force analysis shows. NASA was lucky no one on the ground was killed or injured, the analysis said. "The location of the Columbia breakup was fortuitous for ground populations," said the study. "If the debris field were shifted uprange or downrange a relatively short distance, metropolitan Dallas or metropolitan New Orleans, respectively, may have been hazarded." ACTA Inc., a consulting firm specializing in flight safety risk analysis, prepared the study for the Air Force's 45th Space Wing. Headquartered at Patrick Air Force Base, the wing is responsible for ensuring public safety during launches from KSC and Cape Canaveral Air Station. Safety officials there wanted to determine why there were no injuries or deaths on the ground. Their conclusion: The sparse population in East Texas significantly reduced the probability of ground casualties. Had Columbia broken up less than a minute earlier -- roughly 130 miles to the west -- nearly three times as many people and homes would have been exposed to falling wreckage, the analysis showed. Columbia accident investigators will urge NASA to perform a reentry risk analysis before returning the agency's three remaining shuttles to flight. ["NASA may limit landings at KSC," **Florida Today**, July 31, 2003, p 1A & 6A.]

◆ NASA engineers need high-quality pictures of the shuttle's external fuel tank and bottom of both wings almost immediately after launch so they can get a good look at debris hits and other dangers, Columbia investigators said Wednesday. So the Columbia Accident Investigation Board is urging NASA to beam high-resolution pictures and video back to Earth after all future launches. That way, engineers can see what happened to the shuttle's tank and thermal protection system during the violet ride to space. During Columbia's doomed mission, shuttle engineers did not have close-up images of the chunk of foam

insulation smashing into the ship's left wing 82 seconds after liftoff. The best views that the engineers got were some fuzzy pictures and out-of-focus video captured by ground tracking cameras. The shots were from miles below as the shuttle thundered toward space at more than twice the speed of sound. In the end, the ground team determined the heat shield would hole up based on analysis of those pictures, past experience and antiquated mathematical models. In fact, the heat shield failed. Columbia broke apart during re-entry Feb. 1, killing seven astronauts. NASA ordered its engineers to improve that kind of photography within days of the accident. ["Board: Get better cameras on shuttle," **Florida Today**, July 31, 2003, p 6A.]

July 31: Future space-shuttle crews will inspect their ship for damage on the day after launch with a 58-foot boom attached to the orbiter's robot arm, according to a plan approved by NASA managers last week. A July 31 internal NASA document details the options for surveying the shuttle's thermal-protection system in orbit and recommends testing possible repair techniques for the ship's protective heat tiles on the next mission. An independent board investigating the accident recommended June 27 that astronauts be given the ability to inspect and repair damage to the shuttle's thermal armor in space before the fleet returns to flight. Shuttle Columbia broke up over central Texas on Feb. 1 after a chunk of foam insulation broke free from its external fuel tank during launch and likely punched a hole in a thermal panel on the left wing's leading edge. The resulting breach allowed 3,000-degree gases to enter and eat away the wing as Columbia re-entered Earth's atmosphere for landing. Shuttle managers knew about the foam strike on the day after launch but had no plan in place to inspect for damage and no capability to make repairs. Thursday's decision by NASA's Program Requirements Control Board is a step toward changing that. "It allows you to start designing and manufacturing the boom," a Johnson Space Center manager said. "It also allows you to start planning and training." The decision requires that the shuttle's 50-foot robot arm and the attachable boom fly on all future shuttle missions. The boom will be equipped with cameras to scan the shuttle's surfaces for any signs of damage. Not only will the boom allow astronauts to inspect all parts of the orbiter, it will provide a means of transporting spacewalkers to any sites where repairs are needed. A detailed survey of the wings' leading edges and a sweep of the rest of the shuttle are expected to take two crew members -- one operating the arm and another watching video monitors -- about seven hours to complete. Images will be transmitted to the ground for analysis. The simple, low-tech boom selected by NASA managers was one of the most economical alternatives. The boom will cost about \$1.3 million, although an additional \$5 million will be needed for hardware to store it along a sill in the payload bay and to relocate a UHF communications antenna to another spot. Development time is estimated to be about 6½ months. Web posted. (2003). [Shuttle crews to look for damage [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, August 4].]



KSC Center Director Roy D. Bridges receives the applause of NASA officials and a group of KSC employees assembled in the KSC Training Auditorium. From left are Bridges, NASA Administrator Sean O'Keefe, NASA Associate Administrator of Space Flight William F. Readdy, and KSC Deputy Director James W. Kennedy. The occasion is the announcement of Kennedy as the next director of the NASA Kennedy Space Center (KSC) in Florida. Kennedy has served as KSC's deputy director since November 2002. He will succeed Bridges, who was appointed on June 13 to lead NASA's Langley Research Center, Hampton, Va.

AUGUST

August 1: NASA's prime shuttle contractor is hiring up to 300 workers to speed modifications to Endeavour, a post-Columbia move aimed at putting all three remaining orbiters back into service as quickly as possible. United Space Alliance began hiring additional workers in July. The new hires will undergo about six months of training to prepare them to work on the \$1.8 billion spaceship, which was built as a replacement for Challenger. That, in turn, will enable the company to get a head start on previously scheduled maintenance and modification work on NASA's newest shuttle. The plan now calls for Endeavour to be taken out of service after sister ship Discovery emerges from its current maintenance and modification period. That means work likely would begin on Endeavour later this year or early next year. The hiring spree will raise the company's Florida work force to 6,600 from 6,300, United Space Alliance spokeswoman Kari Fluegel said. The new hires at Kennedy Space Center and the nearby city of Cape Canaveral will include engineers, technicians, support personnel and logistics workers. ["USA to hire 300 workers to overhaul Endeavour," **Florida Today**, August 2, 2003, p 1A & 3A.]

◆ A Nobel Prize-winning member of the board investigating the shuttle Columbia disaster says he fears NASA may be doomed to suffer more tragedies unless it changes the culture that has led to flawed decision-making. "No matter how good the report looks, if we don't do something to change the way NASA makes its decisions, I would say that we will have been whistling in the wind," Osheroff told The Associated Press. Several Columbia board members have said the space agency needs dramatic change, but Osheroff is pessimistic that can be accomplished. Board members and former NASA employees have pointed to attitudes of superiority, fear of retribution by lower-level employees, communications problems and strained relationships between key divisions of NASA as part of its difficult culture. Osheroff is also troubled that some managers who made crucial decisions during Columbia's flight seem unwilling to accept individual blame. NASA Administrator Sean O'Keefe has promised things will change. Last week, he said he was committed to "creating an atmosphere in which we're all encouraged to raise our hand and speak out" when there are life-threatening hazards. ["NASA culture slow to adapt," **Florida Today**, August 2, 2003, p 3A.]

August 2: A last-minute requirement to replace an antenna on the Delta 4 rocket's range-destruct system has prompted Boeing and the U.S. Air Force to postpone this satellite delivery mission at least several days. Efforts to replace and test the new antenna will not be complete in time before the Delta 4 launch team has to give up its reserved dates on the Eastern Range, Boeing officials said in a statement released Saturday. The new Evolved Expendable Launch Vehicle had until Aug. 5 to get off the ground, and now officials are looking at the calendar to see when the Delta 4 might be able to take its turn again. Upcoming launches from Cape Canaveral include a Titan 4 on Aug. 18 and Delta 2 on Aug. 23. Web posted. (2003). [Boeing delays Delta 4 indefinitely [Online]. Available WWW: <http://www.space.com/> [2003, August 2].]

August 5: NASA will respond to the Columbia Accident Investigation Board's recommendations "almost to the letter," a senior agency official said today. But Frederick Gregory, NASA's deputy administrator, downplayed widely publicized criticism of NASA's management culture, saying "it would be difficult for me to define to you what the 'NASA culture' is." Gregory, William Readdy, NASA Associate Administrator for Space Flight, and Bryan O'Connor, associate administrator for safety and mission assurance – all former shuttle commanders – met with reports at the Kennedy Space Center today after meeting with members of an independent board charged with assessing NASA's implementation of the accident board's recommendations. Gregory was repeatedly asked about what NASA plans to do to correct problems with its management philosophy, the so called "NASA culture" that permeates agency operations. Gregory replied that he believed most of the criticism of NASA's operating culture originated with a single CAIB member and that the board's findings would not be known until the panel's report is released Aug. 26. Web posted. (2003). [NASA deputy chief declines to address 'culture' questions [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, August 5].]

◆ NASA officials vowed Tuesday not to dispute or debate the findings and recommendations of the board investigating the Feb. 1 loss of shuttle Columbia and its seven astronauts. Moreover, the officials launched a second independent panel to making certain NASA makes all the technical and institutional

changes recommended in the final report issued later this month by the Columbia Accident Investigation Board. "There will be no attempt whatsoever to argue or defend a recommendation," NASA Deputy Administrator Fred Gregory said at a news conference at Kennedy Space Center. "We will respond to each of the findings and recommendations, and in fact, as you would expect and I would expect, we will go further than that." The independent task force is to make sure NASA does just that. Headed by former Apollo astronaut Thomas Stafford and former shuttle commander Richard Covey, the Return to Flight Task Group will conduct its first public meeting at 11:30 a.m. Thursday at the KSC Visitor Complex. ["NASA won't dispute findings," **Florida Today**, August 6, 2003, p 1A.]

◆ Deputy NASA Administrator Fred Gregory and two other top NASA officials said the agency is making progress on some technical recommendations already issued by the Columbia Accident Investigation Board. But they did not detail how NASA intends to improve: * Photographic capabilities to spot the type of fatal damage done to Columbia's left wing by a 1.7-pound piece of foam insulation that broke free from the ship's external tank 81 seconds after its Jan. 16 launch. * Preflight inspection techniques to better gauge the structural integrity of composite carbon panels that protect shuttle wings from the intense heat encountered during atmospheric re-entry. * Methods for inspecting and repairing shuttle wing panels and thermal tiles while shuttles are in space. The agency also plans to redesign part of the shuttle's external tank to eliminate the foam insulation that doomed Columbia. Consequently, the officials acknowledged that tentative plans to launch Atlantis in March on NASA's first post-Columbia mission are ambitious. "We understand that March may be success-oriented," said NASA space flight chief William Readdy, a veteran shuttle commander and pilot. "But we need to have something to get the team all marching in step." ["NASA working on specific fixes for shuttle systems," **Florida Today**, August 6, 2003, p 6A.]

August 6: The final crew of the Space Shuttle Columbia was memorialized in the cosmos as seven asteroids orbiting the sun between Mars and Jupiter were named in their honor today. The Space Shuttle Columbia crew, Commander Rick Husband; pilot William McCool; Mission Specialists Michael Anderson, Kalpana Chawla, David Brown, Laurel Clark; and Israeli payload specialist Ilan Ramon, will have celestial memorials, easily found from Earth. The names, proposed by NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., were recently approved by the International Astronomical Union. The official clearinghouse of asteroid data, The Smithsonian Astrophysical Observatory's Minor Planet Center, released the dedication today. Web posted. (2003). [Asteroids dedicated to fallen Columbia astronauts [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, August 6].]

◆ A federal court has set the value of moon rocks stolen from the Johnson Space Center in Houston at more than \$5 million, based upon what it cost the United States to go get them rather than what they might sell for on the open market. It what some collectors have said is the first official government valuation of the rocks that American astronauts brought back from the moon on the Apollo expeditions, prosecutors and defense attorneys agree to value moon rocks and Martian meteorites stolen from JSC at between \$2.5 million and \$7 million. The valuation occurred Tuesday just before the sentencing of two NASA interns. The two, were found guilty of collaborating with two other to pilfer the space rocks and other items from JSC and sell them, were sentenced to three years' probation. Some of the defendants took a 600-pound safe full of meteorites, moon rocks and other scientific items from a lab in Houston. They were busted in an undercover FBI sting on International Drive in Orlando. ["Moon rock thieves avoid prison," **Florida Today**, August 7, 2003, p 1A.]

August 7: Kennedy Space Center marked the departure of center director Roy Bridges by naming a bridge after him this week. The Roy D. Bridges Bridge extends over the Banana River on NASA Causeway. Farther west, that road is known as State Road 405. To the east, it connects KSC and Cape Canaveral Air Force Station. Sunday (August 10) is Bridges' last official day at KSC. He will be director of NASA Langley Research Center in Hampton, Va. Jim Kennedy is his replacement. ["Bridge named after Bridges," **Florida Today**, August 8, 2003, p 3B.]

August 8: Members of a task force that will monitor NASA's efforts to resume shuttle flights pledged Thursday to make sure recommendations handed down by a board investigating the Columbia accident are followed. After three days of briefings at Kennedy Space Center, the Stafford-Covey Return To Flight Task

Group used its first public hearing to spell out the group's mission and goals. A recurring theme was a commitment to making sure findings in the Columbia Accident Investigation Board's final report -- scheduled for release in late August -- are fully implemented. "On the surface, it may sound simple, but we're going to check and see if they have done that," said board member Jim Adamson, a retired Army colonel and former astronaut. "We're going to try to drill down into NASA's response to make sure they have met the intent of the recommendation." Chaired by Apollo 10 commander Tom Stafford and former shuttle commander Richard Covey, the 27-member panel was formed June 13 to monitor NASA's plans to safely resume launching its three remaining orbiters after Columbia's Feb. 1 breakup over central Texas. The group is a mix of former NASA astronauts and managers, military officers, academics and policymakers. There are three panel subgroups -- operations, technical and management -- that will oversee NASA's response to the investigation board. Verifying NASA's solutions to operational and technical problems is expected to be relatively straightforward. However, because the investigation board's recommended management reforms could require a lengthy, ongoing process, task-group members conceded it will be hard to make sure everything is fixed before the shuttle's anticipated return to flight in mid-2004. Several investigation board members recently said they consider organizational problems inside NASA to be at least as formidable as the technical challenges. Those problems include an ineffective safety culture and poor communications between lower- and midlevel managers. "Because they [recommendations] may not be expected to be implemented before return to flight, then that puts us in a situation where we have to say 'Well, what can we assess in the time period that we are chartered to do assessments?' " Covey said. "Our approach may be to look at plans, strategies or approaches that may be in place prior to the first flight . . . but it would not be a complete assessment because the real implementation may take longer." Covey flew aboard Discovery on the 1988 mission that returned the shuttle to flight after the 1986 Challenger accident. He said Thursday that there were similarities in the way the decision-making process broke down before both missions. Web posted. (2003). [Watchdogs promise to push NASA hard on shuttle safety reforms [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, August 8].]

◆ The incoming director of Kennedy Space Center says the unexpected will pose the biggest challenge as workers prepare to return the shuttles to flight. A lot of work is taking place on the orbiters, Jim Kennedy said Friday. Workers doing an overhaul of Discovery are removing the rudder speed brake, for instance, and an inspection of Atlantis' wiring is in the works. "We don't know what we're going to find when we get inside of there," he said. "That could be a significant hitch." NASA is aiming for a daytime flight between March 11 and April 6. It would be the first since the Columbia accident. "We think we can make it, but we stay concerned about the unknowns," he said. Kennedy takes over the center this weekend as Roy Bridges leaves to become director of NASA Langley Research Center in Hampton, Va. The management shifts in the agency play into Administrator Sean O'Keefe's "one NASA" policy, which was developed by a team Kennedy led, he said. One move the team suggested was mixing up NASA management. "You grow up in stovepipes, you protect your stovepiped organization," he said. Kennedy said his passion for the "one NASA" policy reflects his commitment to teamwork. He praised Bill Parsons, the new space shuttle program manager at Johnson Space Center: "Bill, better than anybody I know, can coalesce a team across 10 different diverse centers to get us focused on returning safely to flight." As KSC moves toward flying again, the task force headed by former astronauts Tom Stafford and Dick Covey is charged with making sure NASA implements the Columbia Accident Investigation Board's report. "They will provide further authenticity that we have answered all the CAIB's concerns," Kennedy said. The report is due out Aug. 26. Web posted. (2003). [Official: Shuttle work faces the unknown [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 8].]

August 10: Russian cosmonaut Yuri Malenchenko, aboard the International Space Station, married Ekaterina Dmitriev, who was earthbound at Johnson Space Center. The ceremony occurred via video. ["A marriage made in orbit," **Florida Today**, August 11, 2003, p 1A.]

August 12: The launch of the Canadian Space Agency's SCISAT-1 (Scientific Satellite Atmospheric Chemistry Experiment) aboard an Orbital Sciences Pegasus XL vehicle occurred on time from Vandenberg Air Force Base, Calif., at 10:09.33 p.m. EDT. The 330-pound SCISAT-1 spacecraft was placed into a 400-mile-high polar orbit at an inclination of 73.9 degrees following spacecraft separation which occurred 10 minutes, 38 seconds after deployment from the L-1011. The SCISAT-1 spacecraft will investigate processes that control the distribution of ozone in the upper atmosphere. The purpose of the mission is to

measure and understand the chemical processes that control the distribution of ozone in the Earth's atmosphere, particularly at high altitudes. The data from the satellite will provide Canadian and international scientists with improved measurements relating to global ozone processes and help policymakers assess existing environmental policy and develop protective measures for improving the health of our atmosphere, preventing further ozone depletion. This mission is designed to last two years. [“SCISAT Launched Successfully on Pegasus XL,” **KSC News Release #69-03**, August 12, 2003.]

◆ Space Launch Complex 40 was evacuated Tuesday after a propellant leak during the fueling of the Titan 4B rocket. The leak, which occurred about 6 p.m., formed a gas cloud that dissipated before it reached any residential areas, said Bob Lay, emergency management director for Brevard County. The public was never in danger, he said. Officials at Patrick Air Force Base said the plume dissipated harmlessly before reaching populated areas of Kennedy Space Center, just west of the launch complex. About 50 gallons of nitrogen tetroxide was spilled. [“Fuel leak clears Titan complex,” **Florida Today**, August 13, 2003, p 1A.]

◆ NASA's top safety official knew about concerns that arose during shuttle Columbia's final mission, but, like everyone else involved, accepted the conclusion that the spacecraft and crew were in no danger, e-mails released Tuesday show. As the landing date approached, shuttle engineers and managers were worried about damage to the thermal tiles that cover the orbiter's belly – and the doors that protect the landing-gear wells – not the reinforced carbon-carbon panels that wrap the edges of the shuttle's wings. On Jan. 30, Johnson Space Center engineer Carlisle Campbell forwarded an e-mail from colleague Rodney Rocha, outlining the concern about the foam hit, adding “This is confidential, but I just wanted to be sure that you were aware of the potential landing gear door damage.” While engineers were expecting higher temperatures in the area of the landing-gear door, Rocha wrote, they were not predicting major problems – no “safety-of-flight issue.” Early the next day, O'Connor responded, “Thanks for the info. I had heard a little bit of this, but I did not realize so much analysis was required,” O'Connor wrote. Al Feinberg, a spokesman for NASA, said Tuesday that O'Connor perceived Campbell's e-mail as a heads-up from an old friend – the two worked together at Langley in the 1980's – and not a plea for help. The independent board investigating the accident is expected to severely criticize NASA's safety structure in its report, due later this month. The space agency has already announced a new, independent engineering and safety office – completely separate from the shuttle program – that will be based at Langley and report to O'Connor. [“Uneasy e-mails could not shake NASA's feeling that all was well,” **Florida Today**, August 13, 2003, p A7.]

August 15: Despite early concerns about its close relationship with NASA, the Columbia Accident Investigation Board has conducted its probe independently, according to the space agency's inspector general. In a letter sent to National Aeronautics and Space Administration chief Sean O'Keefe on Friday, Inspector General Robert Cobb said by all appearances, the probe into the Feb. 1 breakup of the space shuttle Columbia has been done thoroughly and properly. NASA has not intervened except to provide information to the panel, Cobb said. [“Official: Columbia board was free of NASA influence,” **Orlando Sentinel**, August 17, 2003, p A14.]

August 17: Six months after the Columbia disaster, Congress is still waiting for an indication from NASA about how much money the agency needs, when it will be needed and what's in store for the future of the space program. Part of the problem is the timing: Although NASA has been working on a number of fixes for the shuttle fleet, it is waiting for the report of the independent board investigating the tragedy. That report is expected Aug. 26, late in the congressional budget process and at a time when shoehorning a significant funding increase for the agency would be difficult. Also, a full-scale consideration of the longer term goals of the space program -- and whether the National Aeronautics and Space Administration will press to move beyond the orbits of the shuttle and international space station -- has been almost completely eclipsed by the board's investigation. For now, there appears to be broad support on Capitol Hill for giving NASA the money it needs to get the remaining three shuttles flying again. But when -- or if -- there will be an effort to take a bolder approach to space exploration remains an open question. [“NASA budget is T-minus and holding as Columbia probe is out,” ,” **Orlando Sentinel**, August 17, 2003, p G1 & G5.]

August 18: Americans love their space program, especially after tragedy strikes, according to a USA Today-CNN-Gallup Poll. Six months after shuttle Columbia broke apart during re-entry, support to increase NASA's budget is as high as it has been since the Challenger disaster in 1986, the poll found. People also said that some deadly accidents were "an acceptable price to pay" for space travel. But the poll results and interviews with space historians reveal a troublesome undercurrent: The public's affection for space exploration isn't very deep. Those polled placed a low priority on spaceflight, compared to federal spending on defense and health care. That leaves NASA vulnerable when the economy turns bad or political tides run against its interests. The depth of public support could prove crucial in the coming months. Next week, the board investigating the cause of the Columbia disaster is set to release its findings. Its report is expected to sharply criticize NASA and call for improving safety in the shuttle program. Reaction to the report by members of Congress and their constituents will play a critical role in whether NASA will get the resources it needs. Pollsters interviewed 1,003 people Aug. 4-6. The poll is accurate to within 3 percentage points. It found: Only 17 percent of people said spending on the space program should be cut. That's less than half of the 41 percent who wanted spending cuts in 1993. The level is the lowest since 1989, just months after shuttle flights resumed following the Challenger explosion. The number of people who favor increasing NASA funding, 24 percent, is the highest since 1989. About half of those polled said they prefer current funding levels, the highest since 1986. The public accepts some risk that astronauts will die. Only 17 percent considered any shuttle accidents "unacceptable." Slightly fewer than half, 43 percent, said they would accept one accident every 100 flights; 32 percent said they would accept an accident every 50 missions or more. Two shuttles have crashed in 113 flights. Web posted. (2003). [Americans still support NASA [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 18].]

August 19: The launch of NASA's Space Infrared Telescope Facility (SIRTF) has been rescheduled to no earlier than Monday, Aug. 25, at 1:35:39 a.m. EDT. Winter conditions in the southern hemisphere are bringing high wind and high seas delaying the arrival of a tracking and instrumentation ship in the Indian Ocean that is mandatory to support launch. This ship is used to receive data from the Delta second stage. The progress of the ship toward its support location is being monitored. Weather conditions are gradually forecast to improve over the next few days but the arrival time of the ship on station is tentative. At KSC, the SIRTF Mission Science Briefing has been rescheduled for Friday, Aug. 22 at noon EDT and will be followed by the prelaunch press conference at 1 p.m. EDT. ["SIRTF Launch Retargeted for August 25," **KSC News Release #74-03**, August 19, 2003.]

◆ The head of the U.S. space agency's Langley Research Center said he is pushing for "a very generous independent testing budget" for the newly created NASA Engineering and Safety Center (NESC). The NESC, which will be headquartered at the Hampton, Va.-based field center with some 200 or more engineers spread throughout the space agency, was established in the wake of the Space Shuttle Columbia accident with the intent of giving more clout and independence to NASA's safety watchdogs. Roy Bridges, who took over as Langley's director this month, said Tuesday that he wants the NESC to have sufficient budget to chase down safety concerns with the same kind of rigorous ground testing effort as the dramatic foam impact tests the Columbia Accident Investigation Board conducted this summer. The tests, conducted at the Southwest Research Institute, San Antonio, strongly substantiated the investigators' belief that the chunk of insulating tank foam that struck Columbia's left wing during liftoff caused sufficient damage to cause the destruction of the orbiter as it re-entered the Earth's atmosphere Feb. 1. In the months since the accident, the chair of the Columbia Accident Investigation Board, retired U.S. Navy Adm. Harold Gehman, has publicly chastised NASA's Safety and Mission Assurance organization for lacking the clout and independence it needs to serve as an effective safety watchdog and called for reform. Other members of the Columbia Accident Investigation Board have said that rigorous ground testing could have exposed the space shuttle's susceptibility to foam impact damage before the accident occurred. It is with those assessments in mind that Bridges, a retired Air Force general and former astronaut who was director of Kennedy Space Center during Columbia's last mission, is setting out to empower NASA's cadre of safety experts. "We believe that engineering independence equals safety and that this is the piece of the puzzle that has been missing," Bridges said. The NESC will be directly overseen by Bridge's special assistant Ralph Roe. Roe will, report to both Bridges and Bryan O'Connor, NASA's associate administrator for safety and mission assurance. Although the NESC is not at present expected to have anything approaching veto power over launch decisions, Bridges predicted that "when NESC speaks, people will listen." Web

posted. (2003). [Head of new NASA Safety Center Pushes for Generous Budget [Online]. Available WWW: <http://www.space.com/> [2003, August 19].]

August 21: The White House has turned down a NASA request for an extra \$1.6 billion next year to get the three remaining shuttles flying again and speed up development of the proposed Orbital Space Plane. A NASA budget document also projected that spending on shuttles and the new space plane would require \$20 billion in extra funding during the next five years, according to a congressional aide who has seen the document. That would more than double the current five-year spending plan for the shuttle program. The shuttle budget is \$3.8 billion this year. If the supplement was approved, it projects spending on the shuttles and the new space plane would average about \$8 billion a year during the next five years. Heidi Tringe, spokeswoman for House Science Committee Chairman Rep. Sherwood Boehlert, R-N.Y., said she has not seen the document, but, "We're aware of the request." If approved, the money would represent the largest expansion of spending on human space flight since the Apollo program in the 1960s. It was not clear how much of that money might end up at Kennedy Space Center and Brevard County. However, the supplemental budget request document indicates NASA wants to hire more personnel to oversee the shuttle processing currently conducted at KSC by United Space Alliance, the Boeing and Lockheed-Martin partnership responsible for preparing the space planes for flight. ["Shuttle budget won't get boost," Florida Today, August 23, 2003, p 1A & 2A.]

August 22: Columbia accident investigators will urge NASA to move swiftly to replace the space shuttle while avoiding the mistakes made developing its current fleet of orbiters. In a report to be released Tuesday, the Columbia Accident Investigation Board will chide NASA for pursuing a replacement in fits and starts while failing to come up with a viable next-generation vehicle. They also will report that years of uncertainty over the retirement date for the shuttle fleet prompted the agency to defer or cancel critical upgrades that would have made existing ships safer. "We're going to note that the nation has spent a fair amount of money starting down the road of a next-generation vehicle," investigator John Logsdon, director of the Space Policy Institute at George Washington University, said recently. "And then (we will) fall back and reflect a bit on how that has affected the future of the shuttle program." Five years after the first shuttle flight, and in the wake of the 1986 Challenger explosion, a panel appointed by then-President Ronald Reagan said NASA should replace the shuttle fleet by the year 2000. The National Commission on Space recommendation was part of a larger report that ventured to chart the nation's course in space exploration well into the 21st century. The shuttle's retirement stalled in the late 1980s and early 1990s as NASA focused on building the International Space Station. Then it was pushed back to 2005 when NASA and Lockheed Martin in 1996 set about to build a half-scale prototype of a shuttle replacement known as the X-33. The \$1 billion X-33 project was cancelled in March 2001 due to seemingly insurmountable technical problems. Troubles encountered during the failed project prompted NASA to delay the shuttle's retirement to 2012. And with no replacement in sight, the agency subsequently decided to fly its existing orbiters through 2020. The Columbia board will note that uncertainty over the availability of a replacement spaceship led to a lack of investment in upgrades to critical shuttle systems. The panel also will criticize NASA for managing the shuttle program as if it were a federal project that was going out of business. And they'll scold NASA for not making investments in key upgrades that could make the existing fleet safer. At the same time, the board will advise NASA on what it will take to fly its remaining three orbiters through 2020. But more importantly, the panel will urge NASA to firm up a plan for a replacement vehicle while pointing up pitfalls to avoid in the process. Columbia accident investigators cast a critical eye on a wide range of factors that contributed to NASA's second shuttle disaster in 17 years. Among other things, the investigators will find that:

- Political and budget decisions in the 1970s led to a vulnerable design that places debris sources such as the external tank close to a fragile heat shield.
- NASA's practice of clearing shuttles for flight despite hundreds of known defects made it difficult for managers to identify potentially catastrophic hazards such as foam debris hits.
- Engineers worried about the foam strike requested spy-satellite photos to better gauge damage to Columbia's wing. But managers were more concerned with who made the requests rather than why.

- The Mission Management Team responsible for dealing with in-flight problems failed to meet every day as required, and did not meet at all during the three-day holiday weekend following the launch, when later studies showed decisions had to be made to attempt a rescue.
- The 1990s push to cut the federal deficit and the rising cost of the International Space Station project prompted the White House and Congress to gut the shuttle budget, triggering job cuts and canceling safety upgrades.
- Budget pressures contributed to a decision to turn shuttle operations over to a private contractor. As a result, NASA oversight and the number of mandatory inspections between flights dropped.
- A back-and-forth transfer of program management responsibility caused turmoil. Ensnared at headquarters at the request of Challenger investigators to avoid turf battles, authority was moved to Johnson Space Center in 1996 and back to Washington last year.
- The agency should take pointers from other high-risk enterprises, such as the operation of nuclear submarines, nuclear reactors, offshore oil rigs and aircraft carriers.
- NASA's internal but independent safety organization sold Congress and the American public an overly optimistic assessment of the shuttles' risk. The safety group suffered from a lack of resources, engineering experience and independence.

Web posted. (2003). [Columbia board to tell NASA to replace shuttle quickly [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 23].]

August 23: Engineers are studying a repair for heat-resistant panels on the leading edges of the space shuttle's wings that could eliminate one of the major obstacles to resuming launches. The proposed repair would enable spacewalking astronauts to fix the kind of damage that likely destroyed shuttle Columbia. Investigators have determined that a chunk of foam insulation broke free from Columbia's external fuel tank during launch and smashed a 6- to 10-inch hole in a reinforced carbon-carbon, or RCC, panel on the orbiter's left wing. The Columbia Accident Investigation Board recommended June 27 that the National Aeronautics and Space Administration develop an emergency fix for the critical RCC panels before returning to flight next year. Coming up with a way for astronauts to patch holes in the U-shaped panels in space is considered one of the toughest challenges facing shuttle engineers. One promising repair has emerged as the "leading option," according to an Aug. 15 internal NASA briefing document. Developed by ATK Thiokol, an aerospace company that also manufactures the shuttle's twin booster rockets, the repair is designed to fix holes larger than a half-inch wide. Studies are planned to determine the maximum hole size that could be patched using the technique. The repair works like this: Spacewalkers would insert into the RCC hole an umbrella-like locking device attached to a metal rod. The umbrella would expand inside, and a carbon-carbon surface patch on the other end of the rod would be screwed down over the outside of the hole. Astronauts would then use a tool similar to a caulking gun to inject an adhesive compound into the cavity between the umbrella and the overlying patch. The injected material would fill the void and harden into a plug beneath the patch. Preliminary laboratory analyses have been performed on the repair technique. During one test, an RCC hole 1.5 inches in diameter was plugged, and a propane torch was held against the patch. No flames penetrated during 10 minutes of testing. The fix is one of several possibilities being studied. According to the internal NASA documents, the agency has collected 15 to 20 "reasonable ideas for RCC repair" and is evaluating each. ["Way to fix panels in space shows promise," **Orlando Sentinel**, August 23, 2003, p A1 & A15.]

August 24: Tests prompted by the Columbia accident proved the foam insulation surrounding the shuttle fleet's 15-story external fuel tanks can absorb large amounts of water. The finding is significant because foam filled with water or ice would be heavier than dry foam, thus making it capable of doing more damage if it smashed into the shuttle's heat shield during flight. A piece of foam insulation fell off of Columbia's tank during liftoff in January and struck the shuttle's left wing. It apparently caused enough damage to doom the ship during reentry on Feb. 1. The ongoing research at NASA and universities across the country is helping NASA make progress toward fixing the foam debris problem. The problem has plagued the shuttle program since the first launch in 1981. It is an issue that must be resolved before the

three remaining shuttles can fly again. "It would be great if, in the end, I could feel I had contributed to eliminating this problem," said Douglas Osheroff, the Nobel Prize-winning physicist from Stanford University who serves on the Columbia Accident Investigation Board and did some of the foam tests in his college lab. NASA engineers insisted in the months since the Columbia accident that the foam is impervious to moisture. ["Foam tests hold water," **Florida Today**, August 25, 2003, p 1A & 2A.]

◆ NASA is planning sweeping changes to the space shuttle's operation and management before returning to flight, according to an internal agency road map for safely resuming launches. The changes are detailed in a 121-page report titled "NASA's Implementation Plan for Return to Flight and Beyond." An Aug. 5 draft was obtained by the Orlando Sentinel. "The goal is not only to fix the specific cause of the Columbia accident," the report says, "but also to put in place the comprehensive engineering, operational and managerial improvements that will provide the safety assurance required to return to flight and avoid the risk of overconfidence." Part of the report outlines how NASA plans to respond to five preliminary recommendations made by the Columbia Accident Investigation Board during its nearly seven-month investigation. The rest lists 18 other areas identified by NASA that must be fixed before returning to flight, as well as three longer-term actions. Many of the actions anticipate recommendations likely to be included in the investigation board's final report, which is scheduled for release Tuesday. ["NASA set to revamp system," **Orlando Sentinel**, August 25, 2003, p A1 & A8.]

August 25: NASA's Space Infrared Telescope Facility (SIRTF) successfully launched from Florida's Cape Canaveral Air Force Station at 1:35:39 a.m. Eastern Daylight Time (10:35:39 p.m. Pacific Daylight Time, August 24) aboard a Delta II launch vehicle. Flying eastward over the Atlantic Ocean, the new observatory entered an Earth-trailing orbit the first of its kind at about 43 minutes after launch. Five minutes later, the spacecraft separated from the Delta's second and final stage. At about 2:39 a.m. Eastern Daylight Time (11:39 p.m. Pacific Daylight Time, Aug. 24), about 64 minutes after take-off, the NASA Deep Space Network station in Canberra, Australia received the first data from the spacecraft. "All systems are operating smoothly, and we couldn't be more delighted," said David Gallagher, project manager for the mission at NASA's Jet Propulsion Laboratory, Pasadena, Calif. The last of NASA's suite of Great Observatories, the Space Infrared Telescope Facility will use infrared detectors to pierce the dusty darkness enshrouding many of the universe's most fascinating objects, including brown dwarfs, planet-forming debris discs around stars and distant galaxies billions of light years away. Past Great Observatories include the Hubble Space Telescope, Chandra X-ray Observatory and Compton Gamma Ray Observatory. ["Space Infrared Telescope Facility Lifts Off Aboard Delta II Rocket," **KSC News Release #76-03**, August 25, 2003.]

◆ Release of the Columbia accident report clears the way for an intensive first round of space shuttle hearings on Capitol Hill that probably will be limited only by how long Congress remains in town this year. First up will be the House Science Committee, which plans a Sept. 4 session with Harold Gehman, the outspoken chairman of the Columbia Accident Investigation Board. The Senate Commerce, Science and Transportation Committee will follow the next week, with John McCain (R-Ariz.) wielding the gavel. Administrator Sean O'Keefe and other top NASA managers will spend hours in the spotlight this fall, as there is likely to be at least a hearing a week on the implications of the disaster for the shuttle program and for the U.S. human spaceflight endeavor as a whole. The holiday recess, now expected as early as mid-October, will only be an interlude before NASA's Fiscal 2005 budget request in February reopens the discussion next year. N ["Staring Gun," **Aviation Week & Space Technology**, August 25, 2003, p 21.]

August 26: The Columbia Accident Investigation Board's independent investigation into the February 1, 2003, loss of the Space Shuttle Columbia and its seven-member crew lasted nearly seven months. A staff of more than 120, along with some 400 NASA engineers, supported the Board's 13 members. Investigators examined more than 30,000 documents, conducted more than 200 formal interviews, heard testimony from dozens of expert witnesses, and reviewed more than 3,000 inputs from the general public. In addition, more than 25,000 searchers combed vast stretches of the Western United States to retrieve the spacecraft's debris. In the process, Columbia's tragedy was compounded when two debris searchers with the U.S. Forest Service perished in a helicopter accident. The Board recognized early on that the Columbia accident was probably not an anomalous, random event, but rather likely rooted to some degree in NASA's history and the human space flight program's culture. Accordingly, the Board broadened its mandate at the outset to

include an investigation of a wide range of historical and organizational issues, including political and budgetary considerations, compromises, and changing priorities over the life of the Space Shuttle Program. The Board's conviction regarding the importance of these factors strengthened as the investigation progressed, with the result that this report, in its findings, conclusions, and recommendations, places as much weight on these causal factors as on the more easily understood and corrected physical cause of the accident. The physical cause of the loss of Columbia and its crew was a breach in the Thermal Protection System on the leading edge of the left wing, caused by a piece of insulating foam which separated from the left bipod ramp section of the External Tank at 81.7 seconds after launch, and struck the wing in the vicinity of the lower half of Reinforced Carbon- Carbon panel number 8. During re-entry this breach in the Thermal Protection System allowed superheated air to penetrate through the leading edge insulation and progressively melt the aluminum structure of the left wing, resulting in a weakening of the structure until increasing aerodynamic forces caused loss of control, failure of the wing, and break- up of the Orbiter. This breakup occurred in a flight regime in which, given the current design of the Orbiter, there was no possibility for the crew to survive. The organizational causes of this accident are rooted in the Space Shuttle Program's history and culture, including the original compromises that were required to gain approval for the Shuttle, subsequent years of resource constraints, fluctuating priorities, schedule pressures, mischaracterization of the Shuttle as operational rather than developmental, and lack of an agreed national vision for human space flight. Cultural traits and organizational practices detrimental to safety were allowed to develop, including: reliance on past success as a substitute for sound engineering practices (such as testing to understand why systems were not performing in accordance with requirements); organizational barriers that prevented effective communication of critical safety information and stifled professional differences of opinion; lack of integrated management across program elements; and the evolution of an informal chain of command and decision-making processes that operated outside the organization's rules. This report discusses the attributes of an organization that could more safely and reliably operate the inherently risky Space Shuttle, but does not provide a detailed organizational prescription. Among those attributes are: a robust and independent program technical authority that has complete control over specifications and requirements, and waivers to them; an independent safety assurance organization with line authority over all levels of safety oversight; and an organizational culture that reflects the best characteristics of a learning organization. This report concludes with recommendations, some of which are specifically identified and prefaced as "before return to flight." These recommendations are largely related to the physical cause of the accident, and include preventing the loss of foam, improved imaging of the Space Shuttle stack from liftoff through separation of the External Tank, and on-orbit inspection and repair of the Thermal Protection System. The remaining recommendations, for the most part, stem from the Board's findings on organizational cause factors. While they are not "before return to flight" recommendations, they can be viewed as "continuing to fly" recommendations, as they capture the Board's thinking on what changes are necessary to operate the Shuttle and future spacecraft safely in the mid- to long-term. These recommendations reflect both the Board's strong support for return to flight at the earliest date consistent with the overriding objective of safety, and the Board's conviction that operation of the Space Shuttle, and all human spaceflight, is a developmental activity with high inherent risks. [Executive Summary, **Columbia Accident Investigation Board Report**, Volume 1, August 2003.]

◆ Accident investigators blame the loss of the shuttle Columbia and its crew on politics and culture within NASA, and they state conclusively that foam insulation triggered the disaster. NASA's push to finish building the International Space Station on time and on budget influenced decisions that contributed to the death of seven astronauts, according to the final accident report released Tuesday. "The NASA organizational culture had as much to do with this accident as the foam," the report said. The 250-page report said Administrator Sean O'Keefe and his deputies drew "a line in the sand" regarding the need to meet the Feb. 19, 2004 deadline for completing construction of the space station. Meeting the deadline was NASA's way of proving to the White House and Congress that it could manage a troubled program plagued by delays and embarrassed by at least \$5 billion in cost overruns. But accident investigators did not blame NASA alone. They also found evidence that congressional lawmakers and White House officials did not provide enough money and support for the space agency to make sure the shuttles were safe to fly. "If the nation intends to keep conducting human space flight, it needs to live up to its part of the bargain," the report said. The report concluded the technical cause of the accident was a piece of foam insulation that popped off the shuttle's external fuel tank about 81 seconds after liftoff and struck the orbiter's left wing. The resulting hole allowed hot gases to tear the ship apart during its re-entry on Feb. 1. Investigation board

member Scott Hubbard emphasized there is no doubt about the technical cause. "The foam did it," he said. Neither the accident investigators nor their report mentioned a new target date for launching the next shuttle mission. However, they called Tuesday for NASA to complete some necessary safety measures before flying again: * Identifying risks by spotting trends and "looking relentlessly for the next eroding O-ring, the next falling foam." * Exploring all options for crew survival, such as crew-escape systems. * Stopping unwarranted departures from design standards and adjusting standards only under the most rigorous, safety-driven process. NASA was aiming for a March launch. Web posted. (2003). [Board faults NASA culture, foam for Columbia tragedy [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ An extraordinary effort to recover wreckage from shuttle Columbia and pinpoint the cause of the Feb. 1 accident will cost taxpayers \$454 million, according to figures from government agencies involved. The Federal Emergency Management Agency, which headed up a debris search and recovery operation in Texas and Louisiana, expects to spend \$302 million by the time all bills are paid, a spokesman for the agency said. Total cost to NASA, the lead agency for the investigation: About \$152 million. Launched within hours of Columbia's disintegration over Texas, the unparalleled debris recovery effort brought together more than 130 federal, state and local government agencies as well as 25,000 people from 44 states. The U.S. Forest Service, the Environmental Protection Agency, the Federal Bureau of Investigation and the U.S. Fish and Wildlife Service were among federal agencies that combined efforts with FEMA and NASA as well as local police, fire and sheriff's departments. Helicopters and fixed aircraft conducted searches from the air. Boats and divers recovered wreckage from lakes and ponds. Other people walked shoulder to shoulder to search grids on the ground. The ground, water and air searches covered more than 2.28 million acres as 83,900 pieces of debris were collected and catalogued. The 42 tons of wreckage represented 38 percent of NASA's oldest shuttle orbiter. "The mission was unusual. The resources needed to respond were unusual. And then the number of agencies and of personnel involved was unprecedented," said David Passey, a spokesman for FEMA's Region VI office in Denton, Texas. "It was a team-of-teams effort." Passey said FEMA to date has spent \$118.7 million. The rest of the money will be doled out as FEMA receives bills and then reimburses federal, state and local agencies for costs incurred in the operation. The space agency, meanwhile, expects to spend \$152 million to cover expenses related to the debris recovery effort, the investigation into the accident and support to the board that conducted the probe. The vast majority of that money -- \$112 million -- paid for work performed by NASA civil servants as well as costs absorbed in support of the Columbia Accident Investigation Board, which will release its final report today. NASA spokesman Allard Beutel said \$22 million will cover NASA costs incurred in the debris-recovery operation, including travel expenses as well as the cost to truck wreckage from Texas and Louisiana back to Kennedy Space Center. NASA shipped all Columbia wreckage back to a hangar at the shuttle's home port. Technicians and engineers then laid the debris out on a giant grid as part of the accident investigation. About \$19 million was spent by NASA to cover expenses tallied by the accident board, which opened offices in Houston, Texas, Arlington, Va., and Merritt Island. Board members also traveled extensively during their seven-month probe. The NASA costs will be partially offset by \$50 million in emergency funds approved by Congress shortly after the accident, which killed seven astronauts. A request for a second \$50 million installment from Congress is pending. Beutel also said NASA saved \$32 million by not flying two shuttle missions that had been planned for this year but were indefinitely delayed when the shuttle fleet was grounded. Those savings primarily came from money not spent on overtime or propellant at KSC, Beutel said. The sheer magnitude of the shuttle recovery effort, meanwhile, largely has gone unnoticed by the media, which has been focusing primarily on the investigative work done by the accident board. "It's probably one of the most underreported, important events of its kind. It was such a unique situation, where so many federal agencies had to come together for a recovery effort of this type," NASA spokesman Bob Jacobs said. "I hope no other agency has to go through what everyone went through. But there at least is a model that shows it can be done. It can be done efficiently and effectively." ["Inquiry costs taxpayers \$454 million," **Florida Today**, August 26, 2003, p 1A & 5A.]

◆ Constant budget cuts, work force reductions and other turmoil that affected the shuttle program in the 1990s did not cause the Columbia tragedy, but set the stage for failure, accident investigators wrote in their report released Tuesday. "The measure of success became how much costs were reduced and how efficiently the (shuttle launch) schedule was met," the 13 members of the Columbia Accident Investigation Board observed near the end of its 248-page report. The report identified former NASA Administrator

Daniel Goldin as the central figure in the tumult that swept the vaunted space agency in response to the priorities of the Clinton-Gore administration and the fiscal policies of the Republican majority in Congress. "His tenure at NASA was one of continuous turmoil, to which the space shuttle program was not immune," the investigators wrote in a chapter that dealt almost exclusively with Goldin's legacy. In looking at Washington, investigators found plenty of people to share the blame with NASA. "The past decisions of national leaders -- the White House, Congress and NASA headquarters -- set the Columbia accident in motion by creating resource and schedule strains that compromised the principles of a high-risk technology organization," according to the report's authors. From 1992 to 1998, the shuttle program budget was cut 27 percent. With inflation taken into account, that translates into a 40 percent decline in buying power since 1992. At the same time, government spending on other programs such as defense grew by 25 percent. The work force numbers were even more sobering. The shuttle civil service work force declined from 3,781 in 1993 to 1,718 in 2002. The shuttle contractor work force dropped from 26,310 to 15,744 during the same period. Despite political rhetoric to the contrary, the space program was clearly not a top national priority, the accident investigators observed. With a no-growth budget and NASA leaders unwilling to give up a major program or close one of its centers to save money, Goldin embarked on a nine-year drive to make the space agency do more with less. His motto -- "faster, better, cheaper" -- became NASA's new slogan. Goldin became a polarizing figure, hailed as a visionary by some and lampooned by others as a captain of chaos. His predictions of spending and construction timelines for the International Space Station were revised so often that some lawmakers publicly chided Goldin for redefining NASA's acronym as "Never A Straight Answer." The shuttle program, NASA's most expensive, became the sacrificial lamb. Using a hiring freeze, buyouts, transfers and other strategies, NASA aggressively cut its shuttle work force to meet spending limits. The agency also deferred orbiter safety upgrades. In 1995, an advisory committee led by space veteran Christopher Kraft recommended NASA could cut costs even more by hiring private contractors. Goldin used the report to carry out a major initiative to transfer much of the daily responsibility for processing the shuttles to United Space Alliance, a partnership of Boeing and Lockheed Martin. The switch led to more reductions in NASA's civil service workforce. The decade of downsizing and budget cuts left the shuttle program "excessively fragile" and vulnerable, investigators concluded. Investigators said they found no direct evidence the turmoil directly contributed to the loss of Columbia and her crew of seven on Feb. 1. Web posted. (2003). [Goldin's budgets aided disaster [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ NASA won't be required to have a second shuttle ready to take off on a rescue mission when flights resume, but accident investigators said Tuesday the agency should give future crews a fighting chance to repair serious damage in orbit. In its final report, the Columbia Accident Investigation Board said Columbia's astronauts could have made a spacewalk to inspect the shuttle's wing if NASA managers realized the severity of damage done by a foam debris hit. And while they weren't equipped to make repairs, the astronauts could have attempted a makeshift fix that would have given the crew a chance to survive re-entry and bail out of the crippled spaceship before landing. Additionally, a board-ordered NASA study showed that shuttle Atlantis could have been launched on a hurry-up mission to rescue the crew in what would have been "challenging but feasible" attempt, the accident panel said. "To go take a walk and lean over the wing and see if you had a hole . . . is not very risky and well within the training of the astronauts," retired Navy Adm. Harold Gehman said at a news conference. But "the rescue thing is a whole (other) enterprise, and the risk goes way up." The accident investigators found the astronauts could have performed a spacewalk to fill an assumed six-inch hole in the wing with tools and metal scavenged from the ship's crew cabin. A water-filled bag that would have turned to ice in the extreme cold of space could have held the improvised metal shield in place. The repair scheme was considered "high risk" because NASA could not verify whether the crude patch would have withstood intense heat encountered during atmospheric re-entry. Consequently, "the rescue option had a considerably higher chance of bringing Columbia's crew back alive," the board said. The study showed that Atlantis, which was being readied for a planned March 1 launch, could have been hustled to the launch pad by Feb. 10 "with no necessary testing skipped," the board said. That would have given the agency a five-day window to launch Atlantis on a daring rescue before Columbia's crew ran out of food, water and most importantly, a chemical used to scrub deadly carbon dioxide from cabin air. The idea would have been to stage a series of spacewalks to escort the Columbia astronauts from their wounded shuttle to Atlantis. Columbia would have been guided to a remote-control crash into the Pacific Ocean or boosted into a higher orbit for a subsequent repair mission. In the wake of the accident, senior NASA managers repeatedly insisted that there was nothing the agency

could have done to save the crew even if mission managers had realized the astronauts were doomed. Web posted. (2003). [Rescue attempt 'feasible' [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ Wayne Hale, the veteran flight director was one of many people involved in NASA's fumbled attempt to get the Defense Department to use spy satellites or high-powered telescopes to photograph the underside of the damaged shuttle Columbia in orbit. The Columbia Accident Investigation Board's initial explanation for why no images were taken was "bureaucratic bungling." But the investigators spent considerable energy trying to weed through the conflicting stories told by people who tried to get the military pictures and the people who killed the request. "First we talked to them individually and then as a group," Hale told Florida Today in a July interview. "Everyone involved sat down in a group and tried to talk through what happened, and the more we talked, the more confusing it became even to the people who were involved trying to figure out who said what to who and when." Hale, who since the accident was named deputy shuttle program manager, said the bottom line is no one should be portrayed as hero or villain in the story. "All of us involved in that have regrets that we didn't play it through to fruition." The accident board's final report bears that out. NASA did not get up-close images of Columbia's belly because of miscommunication and mass confusion among engineers and safety officials from at least three NASA sites. The board ultimately determined three requests were made: * Two days into the flight, after seeing the limitations of the launch films from the long-range tracking cameras, Kennedy Space Center's Bob Page asked Hale to help get military satellite or telescope pictures. * Four days later, a manager for prime shuttle contractor United Space Alliance telephoned Johnson Space Center's Lambert Austin with a similar request. * That same day, engineer Rodney Rocha asked his boss to petition or "beg" for outside assistance to use military assets to photograph Columbia because the Debris Assessment Team he co-chaired needed better information to determine Columbia's condition. That didn't include two informal discussions about getting the military's help that involved NASA's space flight chief William Readdy and the agency's top safety officer Bryan O'Connor. "Despite two safety officials being contacted, one of whom was NASA's highest-ranking safety official, safety personnel took no actions to obtain imagery," the report said. In the end, NASA never got the close-up pictures. The engineers struggling to figure out how badly Columbia's heat shield was damaged by foam debris strike after liftoff, were left to rely on a flawed computer tool, fuzzy launch photos and bad assumptions. The problem dogging all of these requests was that, as early as the day after launch, conflicting messages spread through the ranks of the shuttle engineering corps and management about the severity of the debris strike. That colored how people felt about asking the Defense Department to divert top-secret assets to snap pictures of the shuttle instead of surveying Iraq leading up to the war. Some engineers and managers already were dismissing the foam as no big deal while others were talking about working through the weekend on the problem. Some even raised the possibility of cutting the mission short and landing early on Tuesday. The board said the request was formally made to the Defense Department and rescinded within 90 minutes on Jan. 22. Linda Ham, the chairwoman of the Mission Management Team responsible for running Columbia's flight and dealing with problems, asked Austin about the request. The report said Austin admitted making the request outside the chain of command without getting permission from Ham first. Austin also informed her that United Space Alliance wanted the pictures. Ham went on to call several other managers at NASA and United Space Alliance, asking who was requesting satellite imagery -- even though Austin already told her about one request. All of them told her they did not ask for imagery, and Ham later told others no one had a requirement for the pictures. "While Ham has publicly stated that she did not know of the Debris Assessment Team members' desire for photos, she never asked them directly if the request was theirs, even though they were the team analyzing the foam strike," the report said. The Defense Department already was at work on the request when Ham ordered it canceled. A NASA official informed the Pentagon the shuttle program did not need the pictures. Later, the report said, Ham expressed concern that extra time spent maneuvering Columbia to make the left wing visible for imaging would "unduly impact the mission schedule." Web posted. (2003). [Confusion hinders photo effort [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ The NASA managers in charge of Columbia's doomed flight made mistakes that proved fatal to seven astronauts and missed opportunities that could have changed the course of history, investigators said Tuesday. In a damning final report, the Columbia Accident Investigation Board harshly criticized decisions made by NASA's Mission Management Team. "It is tempting to conclude that replacing them will solve all NASA's problems," the board said in its 248-page report. "However, solving NASA's problems is not quite

so easily achieved." NASA has moved the four senior managers involved in the flight. They include: shuttle program manager Ron Dittmore; Linda Ham, who chaired the management team; Ralph Roe, director of vehicle engineering; and Lambert Austin, head of shuttle program integration. Declining to lay direct blame on specific individuals, the board noted that "people's actions are influenced by the organizations in which they work, shaping their choices in directions that even they may not realize." Nevertheless, NASA mission managers were lambasted for: * Relying on a flawed engineering analysis in determining that a foam debris hit in flight would not endanger the shuttle or its crew. An inexperienced team performed the analysis with a rudimentary mathematical tool not designed to assess the damage, the investigators found. * Exhibiting a "low level of concern" for potential damage to the shuttle's left wing. Consequently, engineers "found themselves in the unusual position of having to prove that the situation was unsafe -- a reversal of the usual requirement to prove that a situation is safe," the board said. * A lack of clear communication. "As it became clear during the mission that managers were not as concerned as others about the danger of the foam strike, the ability of engineers to challenge those beliefs greatly diminished," the board found. Managers also "stifled" frank and open discussion on the issue, the investigators said. * A lack of effective leadership. Senior managers "were not engaged" in discussions about the debris hit" and "did not actively seek status, inputs or even preliminary results from the individuals charged with analyzing the debris strike." The failures resulted in "missed opportunities" to better gauge the severity of damage done by the foam debris, including any chance to obtain spy satellite photos of the shuttle as it orbited Earth. The managers also were criticized for meeting just five times during Columbia's 16-day flight, despite a requirement to gather daily. Also at fault: NASA's own independent safety organization. "Safety personnel were present but passive (at management meetings) and did not serve as a channel for the voicing of concerns or dissenting views," the board said. Coupled together, the management blunders helped seal the fate of the crew. Senior NASA managers "failed to fulfill the implicit contract to do whatever is possible to ensure the safety of the crew," the board said. Web posted. (2003). [Poor decisions sealed fate [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ To fly the shuttles past 2010, NASA must undertake an expensive and time-consuming effort to make sure every nut and bolt in the fleet is safe, Columbia investigators said Tuesday. NASA should "develop and conduct a vehicle recertification at the material, component, subsystem, and system levels," the accident report said, and follow these new requirements during future shuttle maintenance. "They've got to assess what they have to spend to keep the fleet flying, quite clearly, and that will take a detailed reading not only of that report but of whatever studies they've done on the engineering aspects," said Henry Hertzfeld, senior research scientist at George Washington University's Space Policy Institute. While the cost is still unclear, "it isn't going to be cheap," he said. The Columbia Accident Investigation Board didn't put a date on how long the shuttles could fly. NASA has studied flying the shuttles past 2020. "Our position is, we are very disappointed that there's not a replacement vehicle, at least on the drawing boards," said the board chairman, retired Navy Adm. Hal Gehman. "If you're going to fly it in the midterm," he added, "you have to change your management scheme." NASA is in the early stages of plans for an orbital space plane, but it has no successor to the shuttle fleet in the works. Web posted. (2003). [Orbiters require intense inspection [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ Kennedy Space Center has a long to-do list after the release of the Columbia accident report Tuesday. "Those are good people," said Rear Admiral Stephen Turcotte, a member of the Columbia Accident Investigation Board. "The people who are down there work. They are working their hearts out." Still, he said, shuttle quality standards at KSC sometimes fall short of aircraft industry or military standards. One major issue is decaying infrastructure, where nets in the Vehicle Assembly Building keep pieces of ceiling concrete from hitting the orbiters, salty ocean air corrodes launch pads and other hardware, and weather can help weaken the orbiters' wings. The board also found problems with the Apollo-era crawlers that haul shuttles to the launch pads. "Considering that the Shuttle will likely be flying for many years to come, NASA, the White House, and Congress alike now face the specter of having to deal with years of infrastructure neglect," the report stated. "Unfortunately, the way to address decaying infrastructure is with money," Florida Space Authority director Winston Scott said. "This is where the Florida Space Authority can help, because our forte is in infrastructure," he said. He cited the building of the Space Experiment Research and Processing Laboratory. "We did that for them. We did it on time and under budget." Coming up with dollars to make repairs isn't easy when the federal government is dealing with such money drains as the war in Iraq, said Ed Gormel, retired space authority director. "If the United States intends to be a

spacefaring nation, they've got to maintain this kind of focus," Gormel said. The board advised that fighting corrosion should be a funding priority, with better evaluation and tracking of its long-term effects. "Corrosion has been a big issue out here for our launch facilities and our readiness for years," KSC Corrosion Testbed Manager Louis MacDowell said earlier this year. "We live on the Atlantic Ocean. Our rocket fuels can be very corrosive to certain metals." An independent review of KSC's quality assurance program also is necessary, the board said. Various quality assurance programs at NASA and chief shuttle contractor United Space Alliance would be more effective if they were integrated, it said. In addition, "Kennedy's Quality Assurance program discrepancy-tracking system is inadequate to nonexistent," the report said. Problems aren't tracked in an easily accessible database. Imaging of each orbiter's flight should be improved, the report said. Poor pictures of Columbia during its ascent limited the ability of people on the ground to gauge the severity of the foam strike. Web posted. (2003). [NASA must fix KSC neglect [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ The backward C-shaped panels along the front edge of a shuttle wing wear down with age. Hundreds of miles of wiring, some tucked into nooks and crevices that shuttle workers can't even get to, might fray or short, leading to potential catastrophe. Many hidden components of the vehicle corrode for a variety of reasons -- from chemicals used during processing to the unforgiving elements at the seaside launch site. Those are just three examples of problems engineers and managers need to pay more attention to on the aging space shuttles. The original designers of the shuttles did not intend for the orbiters to still be flying in 2003. The Columbia Accident Investigation Board said NASA has not been able to treat the shuttles with the caution necessary when maintaining any kind of aging aircraft. "A lot of the equipment that is used on this program is 22 years old. It's frozen in time," board member Rear Adm. Stephen Turcotte said. The deterioration of the wing panels got the most attention in report. The shuttle's chronological age is old compared with other aircraft. That's partly because just as the vehicles and related ground gear are reaching the age at which they need additional care, the space agency budget has been pinched. The reinforced carbon panels on the front edge of each wing lose mass and weaken in time because of oxidation within the material. It's difficult to measure the extent of the oxidation, and NASA testing techniques do not adequately determine how strong the panels are between flights. Most between-flight inspection is visual and, to date, the board said NASA has only destroyed two of the panels to study how much strength they actually lose to oxidation. One observation dealt with the gap between the maintenance overhauls the orbiters go through periodically. The board said NASA has explored the possibility of extending the cycles to once every 12 flights or six years. "This initiative runs counter to the industry norm of increasing the frequency of inspections as systems age, and should be carefully scrutinized, particularly in light of the high-performance orbiters' demands," the report said. Several observations and recommendations call for borrowing high-tech tools used by commercial and military aircraft makers to better detect possible problems or deteriorating of parts. . Web posted. (2003). [Age makes maintenance more difficult [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ Columbia accident investigators hammered NASA Tuesday for launching shuttles with hundreds of known problems that could destroy a shuttle and kill astronaut crews. And they urged NASA to set up an independent group that would have unfettered authority over deciding whether shuttles should be allowed to fly despite existing hazards that could prove catastrophic to future crews. The Columbia Accident Investigation Board said managers responsible for meeting ambitious launch schedules should not have the final say on whether to fly with known flaws to critical systems. Instead, an independent office not financed by the shuttle program should be established to "build a disciplined, systematic approach to identifying, analyzing, and controlling hazards throughout the life cycle of the shuttle system," the board said. That group should have the unfettered authority to determine whether known problems are hazardous and what is -- or is not -- a serious threat to shuttle flight safety. The group also would have an independent say in verifying "launch readiness" for all future shuttle missions. Investigators found NASA now is tracking about 5,396 individual hazards that could cause major systems failures in flight. About 4,222 of those could either threaten mission success or cause the loss of a shuttle crew, the investigators found. Shuttle program managers, meanwhile, have granted waivers on 3,233 of those known problems, the accident board said. No fewer than five independent oversight groups since the Challenger accident have criticized the agency for failing to reform its system for granting waivers. The waivers amount to decisions to accept the risk posed by defects in the orbiters, solid rocket boosters, fuel tanks and other equipment. Not all waivers pose a threat. There are two ways to eliminate them: redesigning the flawed system or purge outdated

requirements no longer relevant based on two decades of flight experience. The idea is to end up with fewer of them for managers to approve and track. But NASA records show that rather than redesigning flawed systems to make them failsafe, shuttle managers routinely develop engineering rationale to justify flying "as-is" without fixing known problems. Web posted. (2003). [Better analysis needed for critical flaws [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ Fixing the foam problem really means more than just fixing the foam. The dilemma goes beyond the tendency of the foam insulation on the shuttles' external tanks to break off in flight and slam into the shuttle. Accident investigators' recommended fixes for the foam debris problem address the broader issues of launch debris in general, and the fragility of the orbiters' heat shields. NASA already decided on the most obvious change -- eliminating the wedge-shaped "ramps" that spawned the chunk of debris investigators say blasted a hole in the front edge of Columbia's left wing during launch. But in its final report, the board gave a multi-part solution to the launch debris problem that has plagued the shuttle program since its inception: Do everything possible to stop foam insulation from breaking free during launch, paying special attention to the ribbed region near where the big orange tank connects to the orbiter's nose. That area is where most of the foam debris has come from during the 22 years the shuttles have been flying. Initiate a program to toughen the shuttle heat shields, possibly by increasing the impact resistance of the black belly tiles and the carbon panels that protect the front of the wings. Establish procedures for the crew to inspect and repair damaged heat-shield components in space. The board recommended all those things happen before the next shuttle flight. NASA said it already is at work on specific solutions, but the agency said it is not ready to discuss specifics beyond elimination of the foam bipod ramps. The investigators stopped short of saying NASA must preclude all foam loss before the next flight because they said that is not possible. "Although tests were conducted to develop and qualify foam for use on the external tank, it appears there were large gaps in NASA's knowledge about this complex and variable material," the report said. "Recent testing conducted at Marshall Space Flight Center and under the auspices of the board indicate that mechanisms previously considered a prime source of foam loss are not feasible in the conditions experienced during tanking, launch and ascent." Other experiments done at the board's request revealed flaws and defects in the foam that NASA had not considered. The board is pushing for a long-term effort at reduction, and then possibly elimination, of launch debris. Web posted. (2003). [Fixes involve more than foam [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ The showering of charred Columbia wreckage on towns in Texas and Louisiana raised questions about public safety, but accident investigators will let NASA decide where shuttles should land in the future. At the same time, though, the Columbia Accident Investigation Board noted Tuesday that NASA shirked an implicit responsibility to analyze the risk of killing or injuring people on the ground in a Columbia-like accident during 22 years of shuttle flights. "NASA made no documented effort to assess public risk from orbiter reentry operations prior to the Columbia accident," the accident board wrote. Moreover, investigators said the agency should study the Columbia disaster "to facilitate realistic estimates of the risk to the public during orbiter reentry." And the agency should develop and adopt a policy that clearly states what level of risk should be deemed acceptable, the board said. Senior NASA managers, meanwhile, are considering changes to longstanding landing strategies. And that could mean limiting landings at Kennedy Space Center. An ongoing NASA assessment on the risk involved could prompt NASA to restrict shuttles from flying over densely populated cities during future reentries. That, in turn, could lead to more shuttle landings at Edwards Air Force Base in California to lessen public exposure to shuttle debris in the event of another accident. Web posted. (2003). [Where can the shuttle land? [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 26].]

◆ The Columbia Accident Investigation Board, in its final report, provided new insights into how the shuttle broke apart and the fate of the orbiter's crew. For the record, here are those observations: At the Board's request, NASA formed a Crew Survivability Working Group within two weeks of the accident to better understand the cause of crew death and the breakup of the crew module. This group made the following observations. The Working Group found no irregularities in its extensive review of all applicable medical records and crew health data. The Armed Forces Institute of Pathology and the Federal Bureau of Investigation conducted forensic analyses on the remains of the crew of Columbia after they were recovered. It was determined that the acceleration levels the crew module experienced prior to its catastrophic failure were not lethal. The death of the crew members was due to blunt trauma and hypoxia.

The exact time of death - sometime after 9:00:19 a.m. Eastern Standard Time - cannot be determined because of the lack of direct physical or recorded evidence. The forensic evaluation of all recovered crew module/forward fuselage components did not show any evidence of over-pressurization or explosion. This conclusion is supported by both the lack of forensic evidence and a credible source for either sort of event. The failure of the crew module resulted from the thermal degradation of structural properties, which resulted in a rapid catastrophic sequential structural breakdown rather than an instantaneous "explosive" failure. Separation of the crew module/forward fuselage assembly from the rest of the Orbiter likely occurred immediately in front of the payload bay (between Xo576 and Xo582 bulkheads). Subsequent breakup of the assembly was a result of ballistic heating and dynamic loading. Evaluations of fractures on both primary and secondary structure elements suggest that structural failures occurred at high temperatures and in some cases at high strain rates. An extensive trajectory reconstruction established the most likely breakup sequence, shown below (see chart on page 77 of the CAIB report). The load and heat rate calculations are shown for the crew module along its reconstructed trajectory. The band superimposed on the trajectory (starting about 9:00:58 a.m. EST) represents the window where all the evaluated debris originated. It appears that the destruction of the crew module took place over a period of 24 seconds beginning at an altitude of approximately 140,000 feet and ending at 105,000 feet. These figures are consistent with the results of independent thermal re-entry and aerodynamic models. The debris footprint proved consistent with the results of these trajectory analyses and models. Approximately 40 to 50 percent, by weight, of the crew module was recovered. The Working Group's results significantly add to the knowledge gained from the loss of Challenger in 1986. Such knowledge is critical to efforts to improve crew survivability when designing new vehicles and identifying feasible improvements to the existing Orbiters. Web posted. (2003). [CAIB addresses fate of Columbia's astronauts [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, August 26].]

August 27: Getting the shuttles ready to return to flight is Kennedy Space Center's top priority, director Jim Kennedy said Wednesday. "We will get the shuttle program the staffing they need in the near term while we continue to fight the battles on Capitol Hill for additional funding and additional resources," he said. Requirements outlined in the Columbia Accident Investigation Board report released Tuesday are prompting NASA center directors to submit new budget requests, he said. Though he wouldn't say there would be additional jobs at KSC, Kennedy said: "The work ahead of us is clear. It is significant and will not result in a loss of jobs at the Kennedy Space Center." The director, who took over the center from Roy Bridges earlier this month, also helped with NASA's investigation into shuttle Columbia's destruction on Feb. 1. "There were very few secrets, if any, that were kept between the CAIB and us," Kennedy said. Work, therefore, has already begun to meet and go beyond the board's requirements, he said. To comply, Kennedy Space Center is:

- * Discussing with the Air Force how to improve imaging of the shuttle during its ascent. For instance, to get three useful views from ground cameras, 10 cameras near the launch pad on the beaches may be necessary.
- * Asking a safety official from NASA's Glenn Research Center to conduct an independent review of critical government inspections at KSC.
- * Looking at how KSC participates in shuttle mission management teams.
- * Coming up with a common definition of foreign object debris, or FOD, that will allow the center to track items dangerous to the shuttle.
- * Having the vendor of reinforced carbon-carbon panels for the shuttles' wings restore the parts to original specifications. KSC also is working on ways to inspect the panels while they are on the orbiter, such as flash thermography.
- * Redesigning ground support equipment to accommodate a change to the shuttle's external tank. The new tank design would eliminate the foam piece that hit and doomed Columbia during launch.
- * Inspecting all other ground support equipment to make sure it meets specifications.
- * "The men and women of Kennedy Space Center understand the challenge ahead and are prepared to deal with it," Kennedy said.

At KSC on Wednesday, United Space Alliance and NASA workers powered up Discovery, marking the official end of the orbiter's major modification period. It is the first shuttle to be overhauled at KSC instead of California. Endeavour is entering a major modification period. Atlantis is the next orbiter to fly, no earlier than March. Web posted. (2003). [KSC promises adaptation to report's goals [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 27].]

◆ NASA will need to make sweeping changes in the way the agency runs its troubled shuttle program to fix the institutional breakdowns that led to the Columbia disaster, the head of the agency said Wednesday. A day after the Columbia Accident Investigation Board indicted NASA for not curing cultural flaws dating back to the 1986 Challenger explosion, the agency's administrator also pledged to make

certain the changes lessen the chance of another disaster. The board's harsh report "covers hardware failures, to be sure, but it also covers human failures, and how our culture needs to change to mitigate succumbing to these failures again," Sean O'Keefe told reporters in a news conference here. "We get it," O'Keefe said, repeating the same three words he spoke when he was the Secretary of the Navy in 1992 and faced the daunting task of righting that service's culture in the wake of the Tailhook sexual-harassment scandal. Almost seven months after the Feb. 1 catastrophe, the Columbia accident board placed equal blame on a foam debris strike to the shuttle's left wing, managerial mistakes, an ineffective safety program and pressure to keep construction of the International Space Station on schedule to satisfy politicians in Washington. O'Keefe's own personal push to complete the station by February 2004 led to that unrelenting pressure, investigators found. And on Wednesday, the NASA chief softened his previously stated intent to get shuttles flying again by next March or April. "When we are fit to fly, that is when that milestone will be achieved," he said. The paramount concern of the agency now is returning shuttles to space in a safe manner and instituting the long-term cultural changes needed to focus the agency on flight safety. Web posted. (2003). [O'Keefe on report: 'We get it' [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 27].]

◆ NASA has the leaders it needs to fix the institutional problems that plague the agency, administrator Sean O'Keefe said Wednesday. O'Keefe said at a news conference he has the right management team in place to tackle the organizational and cultural patterns faulted by accident investigators for compromising the safety of shuttle astronauts. "This is about institutional change," O'Keefe said in response to the 248-page Columbia Accident Investigation Board report. "They are the folks I fully anticipate are going to be the ones who carry this out and accomplish the objectives." But some of those top managers are the same officials who participated in what accident investigators described as a "caste system" of engineers and managers who allowed the space agency's system of checks and balances to wither. For much of the 1990s, Fred Gregory, a shuttle veteran, ran the Office of Safety and Mission Assurance, which Columbia investigators have criticized as ineffective and underfunded. He's now second-in-command at NASA and in a key position to carry out O'Keefe's pledge to reform the space agency. Gregory said he disagreed with the investigators' assessment that his former safety office is "ill-equipped to hold a strong and central role in integrating safety functions." "It is still a strong and robust organization," Gregory told Florida Today. But he said if weaknesses are found, they will be fixed. Gregory said the Columbia board's list of NASA management failures that led up to the Feb. 1 shuttle disaster should not disqualify him or other space officials. "You may characterize me as part of the problem (but) I think I had excellent leadership ability and still do," said Gregory, a former Air Force test pilot and veteran of more than 500 combat missions in Vietnam. "What I've done is to go in to try and determine how you fix problems, whether they be real or perceived." At a news conference Tuesday, board members predicted NASA managers and rank-and-file workers will resist change but at the same time they expressed cautious optimism. In its report, the Columbia board members recounted assurances from NASA officials that the agency was risk-averse and that any employee was empowered to stop shuttle operations at the glimmer of a problem. "Unfortunately, NASA's views of its safety culture . . . did not reflect reality," the report authors concluded. William Readdy, the associate administrator for space flight, disputed that assessment. "What is a little bit perplexing is, I see a culture at every juncture when we had a choice to make between schedule and safety, we always chose safety," Readdy said. For example, Readdy said when a shop floor technician found and reported a hairline fracture in a shuttle part last year, the fleet was grounded while the problem was fixed. The employee was publicly commended, Readdy said. "That pattern of behavior, of rewarding people that do call a timeout, that do bring things to the attention of midlevel and senior management, we celebrate that," Readdy said. Web posted. (2003). [O'Keefe on report: 'We get it' [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 27].]

◆ The NASA manager who oversaw space shuttle Columbia's faulty external tank has been removed in the continuing fallout from the shuttle disaster. Jerry Smelser, external-tank project manager at NASA's Marshall Space Flight Center, has been reassigned and will retire at the end of the year, said Dave King, Marshall director. Web posted. (2003). [NASA Fuel-Tank Specialist Is Removed [Online]. Available WWW: <http://www.story.news.yahoo.com/> [2003, August 27].]

◆ Kennedy Space Center workers are encouraged to speak up about safety concerns and can do so without fear of retribution, the shuttle launch and landing site's top boss said Wednesday. "If you ever see me criticize someone for expressing their open and honest feeling at the Kennedy Space Center, I suggest you call my hand on it and I will resign," KSC Director Jim Kennedy told reporters. The declaration was part of Kennedy's first public reaction to the Columbia Accident Investigation Board's final report, which blamed in equal measure the failure of hardware and NASA's management culture for the Feb. 1 tragedy. That flawed culture allowed, according to the CAIB report, technical problems to go undetected, reliance on past success to cloud judgment and the creation of a decision-making process that circumvented the established rules. Disruptions in communication between engineers and managers at all levels also were cited throughout the report -- prompting Kennedy's pronouncement. And although it's still difficult to specifically define and measure, and managers are not yet completely sure how it will be corrected, the culture will be dealt with, Kennedy said. "We get it. We understand that things have to change. While it is inherently against human nature to make change, we understand that for the safety of flight, for the future astronauts who will fly on the shuttle, we must do business differently," Kennedy said. In the meantime, the KSC workforce already is moving forward with implementing the findings and recommendations of the CAIB report that directly apply to the Florida base. Although he hadn't read all 248 pages of the report yet, Kennedy said he did have a clear understanding of KSC's role in meeting the CAIB's requirements and was optimistic his team would be ready to fly when the agency was. Moreover, the extra work that is likely to be levied on the Florida spaceport will mean there won't be any jobs lost, and could mean new workers will have to be hired, Kennedy said. "We are taking a look at the requirements to do work that was not previously on our plates. And I will tell you that there is an upswing in the requirements, both for our (United Space Alliance) contractor and for NASA oversight/insight activity at the Kennedy Space Center," he said. "The work ahead of us is clear, it is significant and will not result in a loss of jobs." Web posted. (2003). [Florida Launch Site Workers Encouraged to Speak Up for Safety [Online]. Available WWW: <http://www.space.com/> [2003. August 28].]

August 28: NASA has safety issues unrelated to the Columbia accident that the investigative board didn't fully address in its just-released report, and the problems could lead to another disaster if they aren't fixed, one of the investigators said Wednesday. Air Force Brig. Gen. Duane Deal, a member of the Columbia Accident Investigation Board, said he will issue an 11-page "minority report" that will appear within a few weeks as an appendix to the main document. "This is not a dissenting opinion. This is a supplementing opinion," said Deal. "I agree with the report. It's a darn good report. It hammers the things that need to be hammered." Deal said he wrote his report because he helped to conduct about a third of more than 230 interviews the panel had with employees of the shuttle program and felt their concerns for inspection practices and aging equipment were not adequately represented in the investigative report issued Tuesday. "I had some passionate people in front of me," Deal said. "Some came with documentation and said this could cause an accident, or provided it later." "I would ask what were we missing. I would ask that in almost every interview we did. They wanted to get things off their chest," Deal said. "I had people convinced these were very, very serious." Glen Mahone, NASA's chief spokesman, said the agency has not yet been made aware of Deal's concerns. Web posted. (2003). [Minority report on shuttle [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, August 28].]

◆ Kennedy Space Center will fix the shuttle inspection process that Columbia investigators say has grown significantly weaker since responsibility for the orbiters was transferred to a private contractor, the head of NASA said Thursday. Administrator Sean O'Keefe, in an interview with Florida Today, said new center director Jim Kennedy is "already all over this like a bad habit." O'Keefe said he is alarmed to see that quality control inspectors and shuttle workers told accident investigators they were discouraged from raising technical and safety concerns -- some even to the point of fearing for their jobs. "They feel like they're about to receive the wrath of someone. That's the part you've got to stomp out," O'Keefe said, adding he believed before the accident the agency cultivated an environment in which anyone could freely point out such problems. But O'Keefe said KSC leaders will identify and fix any weaknesses in quality control even though the material was buried in the back of the Columbia Accident Investigation Board report and received scant attention from media and government officials this week. There was broad speculation after the Columbia disaster that NASA's decision to transfer shuttle processing to a private contractor and a dramatic cut in the number of mandatory inspection points led to the shuttle tragedy. Accident investigators did not reach that conclusion, but their work did uncover problems with the shuttle

inspection process. That process is critical to safety. There are tens of thousands of opportunities for mistakes and damage to the fragile spacecraft as technicians work on them in the hangars at KSC. Relying on interviews with unidentified shop floor workers and other NASA employees, investigators documented alarming problems: *Surveillance by quality assurance specialists is essentially nonexistent. *Inspectors had to purchase their own tools. *Some quality assurance specialists had no technical or inspection background and little training. *A government manager threatened subordinates who conducted unscheduled hardware surveillance. "I was surprised at the tone of that," O'Keefe said of the stories workers and inspectors told. O'Keefe said he will not have to tell Kennedy to fix that problem -- or how -- because the new center director will not tolerate such behavior. "Anyone who feels like it's a good idea to suppress that kind of thing is gone." The accident investigators also found troubling flaws in the relationship between the few NASA inspectors left at Kennedy and the army of technicians working for contractor United Space Alliance. To save money in the 1990s, NASA transferred most shuttle responsibilities to USA, a partnership of Boeing and Lockheed Martin, whose employees carry out almost all of the modification, maintenance and launch preparation on the orbiters. NASA adopted a "hands-off, eyes-off" approach to inspecting the contractors' work, a decision that investigators said was "unsettling" and "could potentially contribute to a future accident." NASA could tell its inspectors to reject defective work done by USA employees. That would force the contractor to correct problems and reapply for approval. Instead, NASA tells inspectors to cooperate with USA on fixing the problems. This creates a system in which problems become invisible, the accident investigators wrote in their 248-page report. Of 141,127 inspections conducted from October 2000 through March 2003, there were only 20 rejections, a number the report's authors found statistically improbable. "Technicians and inspectors alike confirmed the dubiousness of this rate," according to the report. "Testimony further revealed incidents of quality assurance inspectors being played against each other to accept work that had originally been refused." A spokesman for Kennedy Space Center said it is too soon to tell exactly how agency managers will respond to the reported flaws. ["O'Keefe: Inspection system will be repaired," **Florida Today**, August 29, 2003, p 1A & 2A.]

August 29: Shuttle program manager Bill Parsons gave Kennedy Space Center workers a pep talk Friday in the wake of the release of the Columbia accident report. "I can tell you, the thing that we need to do from a program level is to make sure that you have the tools you need to do your job," he told workers who just completed the overhaul of Discovery. After its official power-up on Wednesday, the shuttle entered processing in preparation for a return to space. "That requires the commitment, the dedication, and the attention to detail that you folks give it each and every day," Parsons said. "I just want you to know how much I appreciate that and how much the program depends on that." Discovery's major modification, as it's called, was much more involved than first planned. For instance, instead of 20 modifications, workers performed 84. Instead of 1,500 structural inspections, there were close to 6,300, said Bill Pickavance, an executive with chief shuttle contractor United Space Alliance, who also addressed the crowd. In its report, the Columbia Accident Investigation Board suggested that NASA needs more consistency and planning in its orbiter overhauls, citing the jump in tasks that Discovery workers had to perform. "Such changes introduce turmoil and increase the potential for mistakes," said the Columbia report, which was released Tuesday. "This report is going to tell us that things have to change," Parsons said. "Well, change is inevitable . . . I will do what I have to do to get us back to a safe return to flight." Web posted. (2003). Shuttle work peps up KSC [Online]. Available WWW: <http://www.floridatoday.com/> [2003, August 27].]

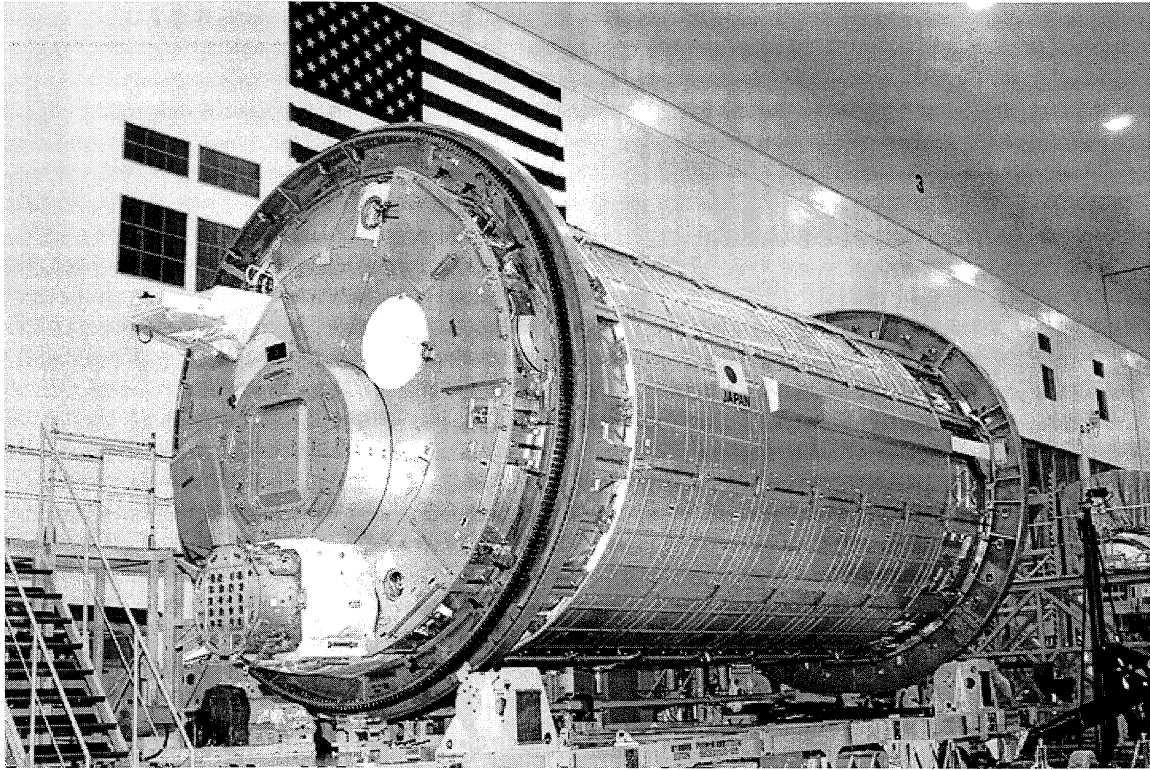
◆ Everyone seems to agree that NASA desperately needs an overhaul of its organizational culture – its way of thinking. Agreeing is the easy part. However, it's not such a quick fix – particularly when NASA appears intent on doing it without major leadership changes. Bust as NASA Administrator Sean O'Keefe, who took the top post in late 2001, goes about the business of retooling the way his agency reacts to problems, at least he has a host of blueprints from which to draw ideas. Virtually every corporate success story – Chrysler in the '70s, Harley-Davidson in the '80s and Continental Airlines in the '90s – has been fueled by substantial change in organizational culture. Discarded were the heavy-handed, "my way or the highway" style regimes, replaced by those where individual workers were encouraged to make, and be part of, important decisions. Where calling attention to a potential problem brought praise rather than scorn. According to the Columbia Accident Investigation Board, the space agency's mind-set created an environment in which a piece of foam could destroy seven lives. Calling the agency overconfident and overly bureaucratic, the board said NASA's past successes have numbed the agency to potential problems.

Reforming culture in federal bureaucracies is no easy task for agency heads, given that they have so many constituencies – the public, Congress, private industry and the White House – to whom they must answer. Whether O’Keefe is able to do this with NASA remains to be seen. Realistically, experts said, it won’t be known for several years whether he’s been successful. [“Corporate success stories offer lessons for NASA,” **Orlando Sentinel**, August 30, 2003, p A1 & A11.]

◆ A Boeing Delta 4 rocket lifted off Friday evening at 7:13 p.m. with the last of a constellation of defense communication satellites. The rocket deployed a Defense Satellite Communications spacecraft. [“Delta 4 lofts defense satellite,” **Florida Today**, August 30, 2003, p 1A.]

August 30: NASA's need for a new spaceship has become a crisis, and the space agency is being pushed to make a decision not unlike the one America made when facing similar circumstances in the early 1960s. The agency has a decade, or less, to develop a new ship that safely can deliver astronauts to and from the International Space Station. The only way to get that job done is not to repeat the mistakes of the past, most notably a penchant to reach beyond current technological capabilities to fabricate a shuttle replacement out of a material critics have branded as "unobtainium." Since the Columbia Accident Investigation Board reported Tuesday that the nation must build just such a craft soon, space historians and policy experts have applauded the recommendation and said NASA could look 40 years back to see a parallel. At that time, the country's leading aerospace engineers were making legitimate progress toward developing revolutionary, winged space vehicles that were the foundation upon which today's shuttle would be designed a decade later. Then came crisis. "The Russians short-circuited the whole process by shoving a guy inside a ball and sticking that on top of a missile, and everyone went crazy and said 'We can do that,' " said Robert Godwin, author and editor of a line of books about space history and spacecraft. "The idea of a winged vehicle was sidelined in favor of using ballistic missiles." The nation needed something simpler, and quicker, in order to meet the nation's goal -- as defined by President Kennedy -- to beat the Russians in the conquest of space to demonstrate our technological superiority. So the country set aside the quest for a winged space plane in favor of ballistic missiles and space capsules that could get that job done on the schedule Kennedy laid down. The accident board seems to be asking NASA to take the same kind of approach -- step back and realize what the immediate need is and meet it. Attempts to do more than what is necessary, or possible, led to failure after failure in replacing the shuttle. The accident board's final report chastised NASA, the White House and Congress for being in a situation where the country does not even have a replacement on the drawing board as the shuttles near their retirement. The board recommended pushing ahead with a replacement as soon as possible that would become the prime method of getting humans to and from Earth orbit, a capability that is necessary not only to keep operating the \$30 billion space station but also to lay the groundwork for more ambitious space exploration goals decades from now. "To demand more would be to fall into the same trap as all previous, unsuccessful, efforts," the report said. Prior to the accident, NASA seemed to be headed more in the direction the board and outside experts suggest -- to define what the country needs and go build that spacecraft using reasonably achievable technology. The project in question is the Orbital Space Plane, which administrator Sean O'Keefe has pitched as a space station crew ferry. Congress is begging for specifics about the design (NASA has not even decided whether it will be a space plane or capsule), the mission and the cost. NASA is making adjustments, and trying to speed the process, in the wake of the Columbia accident. O'Keefe said ongoing strategy discussions about the Orbital Space Plane are closely tied to other decisions, such as how long the shuttles can continue flying and the ultimate configuration of the space station. NASA will be figuring out first what the nation needs the ship to do and then design a craft that meets those capabilities, O'Keefe said. The new push to finish the Orbital Space Plane, perhaps as early as 2008, is much more challenging. Contractors are still awaiting more details on requirements for the vehicle so they can go forward designing it. Coats himself is still working to prove a technology for a crew-escape system that would carry the space plane and astronauts safely away from an exploding rocket. And there is more work to do to make it safe to launch the space plane aboard expendable rockets. [“NASA’s spaceship crisis, pressures mirror shuttle era,” **Florida Today**, August 31, 2003, p 1A & 3A.]

During August: Former astronaut and U.S. Sen. John H. Glenn, Jr., has been named the winner of the Wright Brothers memorial Trophy by the Arlington, Va.-based National Aeronautic Assn. The award is presented annually to “a living individual for significant public service of enduring value, as a civilian, to aviation in the U.S.” [“Who’s Where,” **Aviation Week & Space Technology**, September 1, 2003, p 8.]



In the Space Station Processing Facility, the Japanese Experiment Module (JEM) rests on a workstand during pre-assembly measurement activities. Developed by the Japan Aerospace Exploration Agency (JAXA), the JEM will enhance the unique research capabilities of the orbiting complex by providing an additional environment for astronauts to conduct science experiments.

SEPTEMBER

September 1: NASA's Astronaut Office for years has assigned members to work at Kennedy Space Center. Known as "Cape Crusaders," they keep track of shuttle processing, but chief astronaut Kent Rominger is considering assigning individual astronauts to follow post flight work on each shuttle orbiter. "We can and need to do a better job of staying up with work on the vehicles," he said. Comments from Rominger and Winston Scott, a space veteran and executive director of the Florida space Authority, come on the heels of a scathing report from the board that investigated the Feb. 1 Columbia accident. Unlike the 1986 Challenger investigation board, which urged NASA to place astronauts into management positions, the Columbia panel made no such recommendations. That role today typically is limited to technical assignments astronauts are given if they are not training for a mission. Those assignments range from tracking problems with shuttle propulsion systems – such as its solid-fueled rocket boosters and liquid-fueled main engines – to keeping up with issues associated with shuttle brakes, tires and landing gear. Rominger, noted the ability of the Astronaut Office to oversee safety of flight issues has diminished in recent years. The office, he noted, now has to keep track of issues not only with the shuttle program but also the space station project and plans for the proposed Orbital Space Plane, which is supposed to serve as a crew transport to the outpost beginning around 2008 to 2010. Despite the increasing work load, Scott said one way to more deeply immerse astronauts in safety oversight is to include the Astronaut office in the make-up of NASA's mission Management Team, or MMT, which is responsible for clearing shuttles for launch and dealing with safety issues in flight. Now, NASA's director of flight crew operations at Johnson Space Center in Houston represents the Astronaut Office on the management team. Accident investigators found the management team made mistakes that proved fatal to Columbia's astronauts and missed opportunities to more accurately gauge the amount of damage done to the shuttle's left wing by a foam debris strike early in flight. ["Oversight of post-flight shuttle work may change," **Florida Today**, September 1, 2003, p 2A.]

September 3: NASA Administrator Sean O'Keefe dodged attempts by senators Wednesday to pin blame for the Feb. 1 shuttle Columbia disaster on individual managers at the space agency. Sen. Ernest Hollings, D-S.C., pressed O'Keefe to explain why two key shuttle managers -- Linda Ham and Ralph Roe -- were not disciplined or fired for their roles in the 16-day mission that ended with the deaths of seven astronauts. "I'm trying to fix responsibility," Hollings said at the first congressional hearing on the disaster since the Columbia Accident Investigation Board released its report last week. The House Science Committee will begin hearings Thursday. O'Keefe explained some former managers are no longer at NASA or have been transferred to jobs outside the shuttle program. Members of the accident investigation board did not blame either Ham or Roe for the Columbia accident, but their report did note flaws in the Columbia management team's decision-making process. They also noted managers missed several opportunities to get satellite photographs of the shuttle in orbit. That might have revealed the damage inflicted by a chunk of insulation foam that broke off the external fuel tank and hit the shuttle's left wing. In defending Roe's appointment to the new safety center, O'Keefe paraphrased legendary rocket builder Wernher von Braun: "When you make a mistake, you become that much more valuable." Lawmakers peppered O'Keefe and retired Adm. Harold Gehman Jr., chairman of the investigation board, with questions about some of the most troubling aspects of the panel's 248-page report. O'Keefe offered promises but few details on precisely what NASA will do to recover from the disaster and from investigators' conclusion that the agency allowed its once-potent system of checks and balances to atrophy. Gehman said his board's most important recommendation was to create an engineering and safety office that would function independently of the shuttle program operation. The office would set and control the technical specifications for shuttle operations. It also would control NASA's waiver process, which accident investigators said had grown lax. Separating the engineers from the operations managers would insulate safety decisions from launch pressures and budget constraints, Gehman said. NASA has yet to specify how it would go about creating such an office, which Gehman said would involve a staff of at least 200 engineers. That would represent a substantial cost not currently in NASA's spending plans. O'Keefe said NASA is studying the recommendation and will respond to it. Web posted. (2003). [Senators rip NASA during disaster probe [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 3].]

◆ Margaret Hamilton, leader of the team that developed the flight software for the agency's Apollo missions, has been granted a NASA Exceptional Space Act Award for her scientific and technical contributions. "The Apollo flight software Ms. Hamilton and her team developed was truly a pioneering effort," said NASA Administrator Sean O'Keefe. "The concepts she and her team created became the building blocks for modern 'software engineering.' It's an honor to recognize Ms. Hamilton for her extraordinary contributions to NASA," he said. Dr. Paul Curto, senior technologist for NASA's Inventions and Contributions Board nominated Hamilton for the award. Curto said, "I was surprised to discover she was never formally recognized for her groundbreaking work. Her concepts of asynchronous software, priority scheduling, end-to-end testing, and man-in-the-loop decision capability, such as priority displays, became the foundation for ultra-reliable software design." One example of the value of Hamilton's software work occurred during the Apollo 11 mission. Approximately three minutes before Eagle's touchdown on the moon, the software over rode a command to switch the flight computer's priority processing to a radar system whose 'on' switch had been manually activated due to a faulty written operations script provided to the crew. The action by the software permitted the mission to safely continue. NASA's Space Act Award recognizes a specific scientific or technical innovation of significant value to the agency's aeronautical or space activities. Congress gave NASA the authority to grant up to \$100,000 for each innovation. Included with the award, Hamilton received a check for \$37,200, the largest award to an individual in NASA's history. ["NASA Honors Apollo Engineer," **NASA News Release #03-281**, September 3, 2003.]

September 4: After two days of hearings, congressional lawmakers have just begun to grasp what the shuttle Columbia disaster truly represents. The once-formidable U.S. space program is profoundly troubled and weighed down by an expensive and outmoded vehicle that never delivered on its potential. "I think all of us need to face up to the rather disheartening picture of NASA that has been so painstakingly drawn by the Columbia Accident Investigation Board," said Rep. Sherwood Boehlert, R-N.Y., chairman of the House Science Committee. "If we fail to do so, it's readily apparent that we will just have to go through this same sad exercise again." Boehlert's comments set the tone at a committee hearing Thursday on the investigation board's damning report. Congress began its inquiry into the report with a hearing Wednesday before the Senate Commerce, Science and Transportation panel. The questions individual senators and House members directed at investigators, NASA officials and colleagues at the two hearings displayed a common theme: Can the United States regain the technological and human success it enjoyed during the lunar missions of the Apollo era, and if so, how? "There will be those who say that we should walk away from human space flight as a result of this accident," said Rep. Ralph Hall, D-Texas, senior Democrat on the House Science Committee. "I disagree. The real question is how to make that program as safe and productive as possible." Given the vague signals coming from NASA and the White House, it could be months before the financial cost of the Feb. 1 Columbia loss is known. And it probably will be sometime next year before Congress prepares legislation guiding the future of the space program. It could be even longer before the nation knows whether the Columbia catastrophe was a catalyst for positive change. "For the last 30 years, NASA may well have been on the wrong path with the space shuttle," said Rep. Dana Rohrabacher, R-Calif. "The shuttle has failed miserably to meet its original goals . . . has drained billions of dollars from our treasury and other space programs, and has regrettably cost too many lives." The 13-member accident investigation board declared that the three remaining shuttles can be returned to flight safely if NASA institutes a number of hardware, procedure and management reforms. But the group also had a more expensive and far-reaching recommendation. "Our recommendation is to replace the vehicle as soon as possible," retired Adm. Harold Gehman Jr., who heads the accident investigation board, told House Science Committee members. Web posted. (2003). [Panel questions NASA's resilience [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 3].]

◆ The Gravity Probe B spacecraft (left) is at NASA spacecraft processing hangar 1610 on North Vandenberg Air Force Base. In processing activities last week, the electromagnetic interference (EMI) test was successfully completed. The erection of the first stage of the Boeing Delta II launch vehicle at Space Launch Complex 2 remains scheduled to begin on Sept. 15. Gravity Probe B is an experiment being developed by NASA and Stanford University to test two unverified predictions of Albert Einstein's general theory of relativity. The experiment will check very precisely tiny changes in the direction of spin of four gyroscopes contained in the satellite in a 650 km polar orbit. The gyroscopes will measure how space and time are warped by the presence of the Earth, and, more profoundly, how the Earth's rotation drags space-time around with it. These effects, though small for the Earth, have far-reaching implications for the nature

of matter and the structure of the Universe. ["Relativity theory to be tested by Gravity Probe B spacecraft," **KSC Countdown**, September 4, 2003.]

September 5: House Science Committee Chairman Sherwood L. Boehlert (R-N.Y.) said yesterday that NASA is rushing to meet an "unrealistic" deadline for resuming space shuttle operations and should take more time to absorb the lessons of the Columbia disaster and implement the recommendations of the accident investigation board. On the second day of congressional hearings into the board's findings, Boehlert also criticized NASA for "trumpeting" changes in its safety organization that do not appear to address the problems identified in the investigation. NASA this summer indicated that it would try to resume flights as early as next March or April, but NASA Administrator Sean O'Keefe told the Senate on Wednesday that the three remaining shuttles will remain grounded until officials are certain they are safe to fly. A senior NASA official is scheduled to brief congressional aides today on an initial plan for implementing all 29 of the Columbia Accident Investigation Board's recommendations. The preliminary plan will not specify the estimated cost of making the necessary changes, according to a NASA official. Members of Congress who are writing spending legislation for the coming year are pressing NASA and the White House for estimates of the cost, but administration officials have said it could take weeks or months before that information becomes available. Instead, the report will provide detailed plans for addressing the investigators' recommendations, including a remedy for eliminating the type of foam strike that fatally damaged the Columbia's left wing. The report will also detail NASA's plans for better camera monitoring of future shuttle liftoffs to detect damage to the orbiter; for installing onboard digital cameras that could inspect the shuttle's exterior while in space; for equipping future shuttles with repair kits that could be used to try to patch holes in the shuttle's heat-shielding; and for adopting new techniques for inspecting the structural integrity of the reinforced carbon heat shielding on the shuttle's leading edges between flights. Columbia was destroyed during reentry to the atmosphere on Feb. 1 -- killing the seven-member crew -- when superheated gases penetrated the wing through a hole. Web posted. (2003). [NASA Faulted on Bid to Resume Shuttle Flights [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, September 5].]

◆ Congress is showing no sign it intends to lead the nation's space program out of its current predicament with more money. The House, and now a Senate committee, passed tentative budgets for NASA that contain no cushion for the extra spending the agency will need to comply with the dozens of return-to-flight recommendations made recently by the Columbia Accident Investigation Board. The full Senate soon will take up a \$15.3 billion NASA appropriations bill for the fiscal year that begins Oct. 1. That is approximately the same amount of money given to NASA for the current year's budget and is about \$200,000 less than the total approved in July by the House. In its landmark report on the Columbia disaster, the accident investigation board blamed Congress and the White House for failing to give NASA the necessary money that could have prevented a dangerous 10-year slide during which safety fell victim to budget and schedule pressures. Senators and House members who write the legislation providing funding for NASA programs, including the shuttle, said they want to hear from space agency officials how much it will cost to comply with the Columbia board's recommendations. This week, NASA Administrator Sean O'Keefe acknowledged his agency is negotiating with the White House Office of Management and Budget over future funding needs of the shuttle program but he declined to disclose any cost estimates. NASA officials briefed Capitol Hill staffers Friday on the agency's return-to-flight plans but did not specify a price tag. Congressional appropriators said it would be imprudent to act without an official request from NASA and the White House. "It would be helpful if the administration sent us a signal," said Rep. James Walsh, R-N.Y., chairman of the House appropriations subcommittee on veterans, housing, NASA and other independent federal agencies. The spending bill passed by the Senate Appropriations Committee makes no increase or decrease to the shuttle budget, but it cut approximately \$200 million from the International Space Station. With a reduced crew and Russia providing crew and cargo transport to and from the station, Senate appropriators said the money could be better used elsewhere. Once the Senate passes the appropriations bill containing NASA's budget, the legislation will have to be reconciled with the House version in a conference committee. As long as Congress is in session, the White House could address the shuttle funding issue with a supplemental request for funds. It remains unclear whether that will happen or if NASA and the White House will wait until early next year to reveal their spending plans when the budget request for fiscal 2004 is sent to Congress. Web posted. (2003). [Congress balks at NASA boost [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 5].]

◆ NASA said it will suspend night launches and institute new checks and balances over contractors and its own managers before returning the shuttle fleet to space. Astronauts already are testing ways to repair a damaged heat shield in space, and the first redesigned fuel tank, without the piece of foam implicated in the Columbia accident, is to be delivered to Florida by year's end. Less than two weeks after investigators demanded sweeping reforms, NASA officials on Friday privately outlined for members of Congress a detailed plan and schedule for fixing the ills that doomed Columbia. The "implementation plan," indicates NASA is on track to fulfill most of the Columbia Accident Investigation Board's recommendations in time to launch again in March if all goes as planned. However, the plan also shows the agency may need more time with some of the broader organizational changes. Hearings scheduled next week, and throughout the fall, will focus sharply on the proposed changes NASA is recommending and whether they meet the spirit and the letter of the report issued by the Columbia board, he said. Michael Kostelnik, NASA's Deputy Associate Administrator for the shuttle and International Space Station programs, briefed key members of the Senate and the House on the plan. The document says NASA also plans to revamp its safety organization, including creating a new safety and engineering center at Langley Research Center that will be independent from the shuttle program. The agency, in its document and briefing, agreed that does not meet the full intent of the board's recommendation for an independent engineering body that would review a wide range of decisions made by shuttle managers. The program is reviewing all "waivers" of shuttle safety requirements. NASA's plan says that review is under way now and "waivers will be retained only if the controls and engineering analysis associated with the risks is revalidated. This review will be completed prior to return to flight." Web posted. (2003). [NASA details plan to return shuttles to flight [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 5.]

September 8: A former NASA employee charged with stealing a 2-inch piece of debris while helping to recover parts of the space shuttle Columbia in Texas has reached a plea agreement that will likely keep him out of prison. Michael Pankiewicz, 44, pleaded guilty last month to theft of government property. The single misdemeanor carries a maximum year in prison and a \$100,000 fine. Prosecutors will seek only probation when he is sentenced Nov. 10, according to documents filed in federal court. Pankiewicz was charged in April with three felonies of stealing government property, transporting stolen goods across state lines and making false statements. He faced a maximum 25 years in prison and a \$750,000 fine. Web posted. (2003). [NASA Worker Pleads Guilty to Theft [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, September 8].]

◆ As NASA begins its return-to-flight plan in earnest, Senate appropriators have set down a series of new oversight requirements for the space agency. In a committee report attached to a spending bill and released Monday, senators outlined changes they want accomplished at the agency in addition to all the reforms required by the Columbia Accident Investigation Board. While saying little about the performance of NASA personnel involved in the doomed Columbia mission, the Senate report blamed the Aerospace Safety and Advisory Panel for failing to "provide clear warning signs" prior to the Columbia accident. As part of a bill providing \$15.3 billion in funding for NASA in fiscal year 2004, senators direct NASA Administrator Sean O'Keefe to reconstitute the long-standing safety panel with "recognized safety, management and engineering experts." It specifically suggests replacing some panel members with some of those who currently serve on another oversight group, the Stafford-Covey Return to Flight Task Group. That panel is overseeing NASA's compliance with the accident investigation board's recommendations. The Aerospace Safety and Advisory Panel was chartered by Congress in 1967 after the deadly Apollo 1 fire, to act as an independent body advising NASA on the safety of operations, facilities and personnel. The Senate legislation faulted the safety panel for failing to "provide the required checks and balances in its review of the safety procedures at NASA to observe the culture deficiencies" cited by Columbia investigators. Ironically, prior to the Columbia tragedy, the safety panel had been seen as growing increasingly strident in its annual review of the shuttle program. Former longtime director Richard Blomberg was an outspoken critic of the program's weaknesses but was replaced last year along with several other panel members. The pending legislation also directs the NASA administrator to create a separate, independent oversight panel to scrutinize the space agency's growing orbital space plane program. Web posted. (2003). [Senate spending bill seeks to tighten NASA oversight [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 8.]

◆ NASA's first post-Columbia shuttle flight will be a mission aimed primarily at testing new orbital inspection and repair techniques rather than ferrying a fresh crew to the International Space Station, officials said Monday. The unfinished station still will be the destination for the flight, but astronauts aboard shuttle Atlantis now will focus more on demonstrating new ways to find and fix the type of damage that doomed Columbia's crew. "Their mission content is going to take a dramatic turn from what they had previously been training for," said NASA astronaut James Halsell, co-chair of the agency's so-called Return-To-Flight team. "But that is not in any way unheard of in the history of the shuttle program. Many crews have had to step back (and) set aside what they had been working on and accept new challenges." The change in plans was announced as NASA unveiled a 156-page document that outlines agency plans to return shuttles to flight in the wake of a blistering Aug. 26 report from the Columbia Accident Investigation Board. Among other recommendations, the 13-member board urged NASA to develop a means to inspect and repair vulnerable shuttle wing panels and thermal tiles in orbit. Web posted. (2003). [1st shuttle flight to test repair methods [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 8.]

◆ Workers at the Kennedy Space Center Visitor Complex are expected to vote on a new contract soon that would give them their first pay raise in two years, but also would require them to start paying for some of their insurance premiums. The proposed three-year contract would be for about 130 employees of Johnson Controls, including bus drivers, mechanics, landscapers and maintenance personnel who work at the Visitor Complex – one of Brevard County's top tourist attractions. Johnson Controls is a sub-contractor of Delaware North Parks Services of Spaceport, the NASA contractor that manages the Visitor Complex. The Visitor Complex workers are represented by the International Association of Machinists and Aerospace Workers, District 166, Local 773. ["Visitor Center worker pact near," **Florida Today**, September 9, 2003, p 1C & 2C.]

◆ The next flight of a space shuttle – when it happens—will be a test run to try out safety modifications that will be added to the fleet in the coming months, NASA officials said Monday. The mission, as scheduled before the Feb. 1 Columbia accident, was supposed to be another step in the construction of the international space station. But while shuttle Atlantis, with astronaut Eileen Collins at the helm, will still dock with the orbiting laboratory, managers are leaning against the idea of using the mission to take a new crew to the station, shuttle-program manager Bill Parsons said at a press briefing in Houston. That's because Collins and her crew, in addition to opening the post-Columbia era for the shuttle, will be asked to perform a host of tests and demonstrations on the new additions to the orbiter. NASA, which Monday publicly released its preliminary plan for returning to flight, hopes to have everything from new cameras to an in-orbit repair kit on board by the time of the next launch. William Readdy, NASA's top spaceflight official, said the agency is working on implementing the recommendations issued last month by the Columbia Accident Investigation Board, plus additional changes of its own devising. Readdy and Parsons stressed that while the return-to-flight plan is aimed at a launch window between March 11 and April 16, there is so much work to be done that it's impossible to set a concrete date. Readdy said the other windows that have been identified so far are between May 19 and June 28, and July 18 and Aug. 26. ["NASA to prepare Atlantis for test-run flight in '04," **Orlando Sentinel**, September 9, 2003, p A11.]

September 9: NASA is looking for outside help on shuttle wing repairs and safety culture changes, two of the biggest hurdles in its return-to-flight effort. Seven months after the Columbia tragedy, the space agency still is struggling to develop scorch-proof patches for the thermal panels along the leading edges of shuttle wings. And it is only now coming to grips with the fact that a broken safety culture, along with a stray piece of insulating foam, caused the disaster. "This is one that probably NASA will not be able to bootstrap itself," said former shuttle commander William Readdy, NASA's top spaceflight official. "I'd be really way out in front of my headlights here if I were to tell you that I've got the answer or even how to go about answering the question because I'm a test pilot. I'm an engineer," he said. "Really, the whole notion of culture, I think, is probably left to the professionals." Officials in charge of NASA's return-to-flight plan, made public Monday, said they are also under orders from the top to seek outside guidance for providing wing repair kits. "We will not be guilty of any not-invented-here-syndrome," said astronaut James Halsell, who is overseeing the effort. When shuttle launches resume sometime next year, the first mission will essentially be a test flight, with astronauts inspecting their ship and practicing repair techniques to guard against another Columbia-type disaster. NASA considered flying the minimum number of astronauts and keeping the mission as short as possible. But it decided to go with a full set of six

or seven astronauts on a normal-length mission of about a week and a half to perform some overdue repair work at the international space station. "If we're going to go through all this risk to get there and do that, we ought to go ahead and make sure that we do some of those things that are important to the international space station because if we don't do those things, it raises the risk of the station," said Bill Parsons, the new shuttle program manager. No firm launch date has been set for the next shuttle, Atlantis. But in all likelihood, it will not deliver a fresh crew to the space station as originally intended. Instead, the focus will be on inspecting the shuttle for exterior damage, using cameras on both the shuttle and space station, and practicing techniques to patch crippling holes like the one that marred Columbia's left wing. Other objectives, like delivering supplies to the space station, will take a back seat, Readdy said. Readdy said the next flight may not represent as much of a shakedown as the first shuttle trip in 1981, a two-day mission by Columbia and just two pilots. Web posted. (2003). [NASA Looks Outside for Repairs, Changes [Online]. Available WWW: <http://www.washingtonpost.com/> [2003, September 9].]

◆ A Titan rocket lifted off from Complex 40 with a roar over the Space Coast early today, brilliantly illuminating a bank of low clouds as it soared toward orbit. The launch was delayed past its original launch time after a temperature problem with the rocket's Centaur upper stage. This is expected to be the last Titan-Centaur launch. The Titan lifted off from Cape Canaveral Air Force Station at 12:29 a.m. ["Titan carries spy satellite into orbit," **Florida Today**, September 9, 2003, p 1A.]

September 10: Workers at Kennedy Space Center are packing up the 84,000 pieces of the space shuttle Columbia for storage. But unlike debris from the Challenger, some remnants will be available to researchers and perhaps someday put on display in a museum. "The overall goal ... was to make Columbia available to do further science and research, not only by the shuttle community but other contractors, universities and scientists," said Scott Thurston, who was the vehicle manager for Columbia. NASA hasn't decided whether any pieces of the shuttle will ultimately be given to the Smithsonian National Air and Space Museum in Washington, but that institution has the right of first refusal for all excess NASA property. "They know our interest and they're considering a variety of options," said museum space history curator Valerie Neal, who has toured the debris spread out in a space center hangar. The debris from Challenger was put into two abandoned missile silos at Cape Canaveral Air Force Station after the 1986 disaster. NASA chief Sean O'Keefe has vowed that will not happen with Columbia. Next week, boxes of the collected parts, representing 39 percent of the shuttle, will be trucked 1 1/2 miles away to the 16th floor of the Vehicle Assembly Building. That is the building where the shuttle orbiter is attached to the external fuel tank and solid rocket boosters before launches. Web posted. (2003). [NASA Begins Storing Shuttle Debris [Online]. Available WWW: <http://www.nytimes.com/> [2003, September 10].]

◆ A White House mystery panel emerged Wednesday as a new focal point for member of Congress worried about the future of the U.S. space program. During pointed questioning from lawmakers at the House Science Committee hearing, NASA Administrator Sean O'Keefe was reluctant to disclose details of the inter-agency working group preparing a set of recommendations for President Bush. The group meets periodically and includes the president's science advisor, John Marburger, and others from the Defense and Commerce departments, O'Keefe said. The group will give President Bush a set of options on the future direction of the U.S. space program in the wake of the Feb. 1 Columbia tragedy, O'Keefe said. He did not specify when the group's work would be done. In the near term, NASA is focused on responding to the investigation board's many recommendations so it can resume shuttle flights to the International Space Station project. ["Mystery' space panel exposed," **Florida Today**, September 11, 2003, p 1A & 3A.]

September 11: Lawmakers expressed concern today that NASA was rushing to resume space shuttle flights before fully carrying out the recommendations of the panel that investigated the Columbia disaster. Questioning the space agency's administrator, Sean O'Keefe, for the first time since completion of the investigation, members of the House Science Committee said they were uneasy about plans to start flying again as early as March and to conduct as many as four missions in 2004. "I'm still concerned that the target is exceedingly ambitious and could skew NASA's efforts to return to flight," said the committee chairman, Representative Sherwood Boehlert, Republican of New York. Mr. Boehlert noted that the accident board had found that excessive schedule pressure to launch appeared to have made NASA managers less safety-conscious. Mr. O'Keefe, repeating assurances that the agency gave on Monday, when it issued its preliminary plan to resume shuttle missions, replied that the March goal was very flexible.

Plans for the first flight, by the shuttle Atlantis, are "milestone-driven, not calendar-driven," he said, and the agency will adjust the schedule for later flights to be sure there are no safety compromises. Harold W. Gehman Jr., the retired admiral who led the 13-member board that investigated the Columbia accident, also attended the hearing today. He appeared before the committee last week to discuss the Columbia Accident Investigation Report, issued by the board on Aug. 26, which included 15 recommendations for NASA to carry out before returning the shuttles to space. Admiral Gehman declined to discuss NASA's plan today, saying he had only glanced through it. He also said he had no immediate plans to discuss it with a NASA task force, meeting in Houston this week, that is charged with monitoring the agency's compliance with the recommendations. Having met several times with that panel, headed by the former astronauts Thomas P. Stafford and Richard O. Covey, Admiral Gehman said after the hearing that he was confident of its competence and independence. Web posted. (2003). [House Panel Wary on Plan for Shuttle [Online]. Available WWW: <http://www.nytimes.com/> [2003, September 11].]

◆ NASA plans to issue a request for proposals for the Orbital Space Plane (OSP) by about December, and likely will award a contract next summer, aerospace agency Administrator Sean O'Keefe said Sept. 11. In a roundtable with reporters, O'Keefe said the program's level two requirements have just been completed and industry officials will be briefed on them in "the next couple of months." NASA also is preparing briefing material for members of Congress on the possibility of accelerating the program, and what that would cost. O'Keefe said that material has been prepared, but he did not know if it has been delivered to lawmakers. It is "a full lay-down of everything involved, and all of the options of what acceleration would take," O'Keefe said. NASA had planned to use the OSP for emergency crew return from the International Space Station by 2010, and for ferrying crew to and from the station by 2012. The loss of the shuttle Columbia and concerns about the safety of the rest of the shuttle fleet has prompted some lawmakers to call for accelerating OSP development. O'Keefe said the OSP schedule would allow for accelerating the program. "If you keep to that kind of a plan, whether the asset that [results] from this delivers in 2010 or any other year, it means the process is moving along at a pretty rapid clip" and could be accelerated, O'Keefe said. In the meantime, he said NASA has contingency plans for the next couple of years for accelerated Russian Progress flights to resupply the space station. He acknowledged that Russia has financial problems, but said, "so do we." NASA is in the "middle phase" of preparing its fiscal 2005 budget, O'Keefe said, which will reflect changes being made as NASA moves to implement the sweeping safety-related changes called for by the Columbia Accident Investigation Board (CAIB), which released its report late last month. The overall costs of responding to the CAIB should be less than \$1 billion for fiscal 2004, O'Keefe said. "This is nothing that requires a massive engineering redesign," he said. "Mostly, it's going to be personnel costs ... I can't imagine it's going to hit that number." However, some programs, like NASA's new safety center won't cost much for the first couple of years but then will require sustaining funding that "will not be cheap," O'Keefe said. "... The timing of the board report and this debate [over NASA's future] is really quite opportune" in terms of the FY '05 budget process, O'Keefe said. ["NASA planning to release Orbital Space Plane RFP in December," **Aerospace Daily**, September 11, 2003].]

◆ NASA's plan to get the shuttles flying again has a hole in it, the co-chairman of a key review panel said Thursday. A 156-page return-to-flight blueprint drafted by the space agency offers few details on three essential changes recommended by the Columbia Accident Investigation Board, said Richard Covey. Covey is a former astronaut who piloted the first shuttle flight in 1988 following the Challenger disaster. He also is co-chairman of the "Stafford-Covey Task Group" charged with evaluating NASA's compliance with safety improvements the Columbia board said are necessary before the three remaining shuttles resume flight. The Columbia board recommended NASA create an Independent Technical Authority to make critical engineering decisions regarding the shuttles. It also recommended strengthening the office in charge of safety policy at NASA headquarters by giving the office its own budget and direct authority over the shuttle program. Finally, board members said NASA must give a single office responsibility for all shuttle components, replacing the current arrangement in which a separate office is responsible for each component. NASA's return-to-flight plan, released Monday, stated the agency is committed to following the recommendations and will form teams to assess its options. That response is "problematic," Covey said Thursday at a press conference at Johnson Space Center in Houston. "The agency has some work to do there," he said. Retired Adm. Harold Gehman Jr., chairman of the Columbia Accident Investigation Board, repeatedly said creation of the Independent Technical Authority is central to fixing NASA's broken safety system. Some shuttle fixes NASA has undertaken will be closed out quickly and simply, Covey said. He

pointed to the progress the agency already made to improve the devices that catch debris when explosive bolts fire to separate a shuttle's external fuel tank from the orbiter after launch. However, Covey said NASA might not come up with similarly straightforward solutions regarding recommendations for an Independent Technical Authority and for other safety improvements and oversight of shuttle components. "There will be cases where the intent of the (Columbia Accident Investigation Board) recommendations may prove to be difficult to meet in a certain time frame," Covey said. "That's where we could weigh in and identify whether alternatives are appropriate." Web posted. (2003). [Former astronaut faults shuttle plan [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 11].]

◆ Given enough money, NASA could have a new orbital space plane up and running in five years, and the nation's three remaining shuttles eventually could be used only for unmanned cargo missions, NASA's top official told Congress on Wednesday. "It can be done," NASA Administrator Sean O'Keefe told members of the House Science Committee. How much that would cost and whether the White House would back the idea have yet to be determined, O'Keefe said. Speeding up development of a new spacecraft to carry humans to the U.S.-led international space station is among the options being considered by a loosely knit interagency group that is reworking the nation's space policy in the wake of the Feb. 1 Columbia shuttle accident, he said. President Bush's current budget plans call for the proposed spacecraft, which is in the preliminary design stage, to be operating as an emergency escape pod for the space station by 2010 and as a crew transport vehicle to the orbiting outpost by 2012. Accelerating that schedule would require a major increase in near-term funding, O'Keefe said. "That's gonna cost, and it isn't going to be cheap," he said. O'Keefe declined to provide a cost estimate, saying those numbers still are being crunched. Rep. Joe Barton, R-Ennis, who has been insisting for months that humans should never fly aboard the shuttle again, pushed O'Keefe to come up with the details of what it would cost to get the space plane running by 2008. He also asked for estimates of what it would cost and how long it would take to modify the space shuttles to fly automated missions to complete the station's construction and to deliver supplies to its crew. Barton said he would like to talk with O'Keefe about a fiscal year 2004 supplemental budget request to accomplish those goals. O'Keefe said he would look into the matter and report back. The comments came during a contentious 3 1/2-hour hearing during which Democratic and Republican lawmakers alike demanded that NASA and the White House lay out their vision for future space exploration before Congress signs off on funding for new spacecraft and other projects. Retired Adm. Harold Gehman, chairman of the Columbia Accident Investigation Board, who also testified before the committee, agreed that policymakers should reach a consensus "on what you want to do, then design the vehicle." Gehman's 13-member investigative board released its report last month on the shuttle accident that killed seven astronauts. Web posted. (2003). [NASA could build new craft in 5 years [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, September 10].]

◆ Even as NASA carefully lays out its plan to return the space shuttle to flight, workers at the Kennedy Space Center are busy with a list of things to do on each of the surviving space planes. "It's anything but people standing around here looking for work to do," KSC spokesman Mike Rein told *SPACE.com*. The next shuttle scheduled for launch is Atlantis. Although the mission's exact details have yet to be decided, KSC workers this week have been active in the orbiter's cockpit removing hardware for inspections, checking out the environmental control system in Atlantis' cargo bay and examining the miles of electrical wiring that snakes through the vehicle. The major effort in the Orbiter Processing Facility hangar centers on Atlantis' wing leading edges and the reinforced carbon-carbon (RCC) panels that shape the front of the wings and are designed to protect the shuttle from the hottest temperatures of re-entry, Rein said. It was a hole in an RCC panel on Columbia -- created by a chunk of foam that fell from the external tank during launch -- that triggered the series of events that led to the Feb. 1 loss of the shuttle and its crew. As a result, much of the return to flight attention is on making sure those RCC panels are in good shape after flying all these years. In fact, the Columbia Accident Investigation Board has required the panels be inspected between future flights. In Atlantis' case, all of the RCC panels were removed and shipped back to their factory for inspections as engineers still are determining the best way to inspect the panels in place on the shuttle wings, yet without damaging the structure. Three of the panels have since been returned from the vendor, are back up to their original standards and are being re-installed, Rein said. Nearby, another set of shuttle workers recently had a reason to cheer when they turned on the electrical power to Discovery for the first time in months. "It was a big milestone," Rein said. Discovery has been going through an Orbiter Major Modifications (OMM) period, the first one since NASA officials decided to do all OMM work in

Florida instead of the shuttle factory at Palmdale, Calif. In performing an OMM the shuttle was basically gutted so all of its major systems, structures and wiring could be inspected. As the shuttle was put back together, new and improved systems were installed in some areas. The OMM work began before the Columbia tragedy and continued in the aftermath, giving a team of several hundred workers assigned to Discovery something to focus on and keep the shuttle program moving forward, Rein said, noting that the OMM for this orbiter came in "on budget and on time." Meanwhile, NASA's newest shuttle -- Endeavour -- is in the early stages of its own OMM here in Florida. This week workers are removing Endeavour's Orbital Maneuvering System (OMS) pods from the tail and trucking them over to a hazardous processing facility. The OMS pods contain the rocket engines a shuttle uses after launch to adjust its orbit, as well as to de-orbit to begin the trip home. A collection of steering thrusters also is contained in the pods. At the same time, inspections are taking place inside Endeavour's main propulsion system plumbing. Workers are looking for signs of any cracks in the critical piping that carries the supercold liquid hydrogen and liquid oxygen from the external tank to feed the three Rocketdyne main engines. Web posted. (2003). [Shuttle Team at Kennedy Space Center Kept Busy [Online]. Available WWW: <http://www.space.com/> [2003, September 11].]

September 12: Debris from the space shuttle Columbia, collected in a huge hunt for clues after the February 1 crash, was packed up for storage this week but will be available to researchers indefinitely, NASA said. The 84,000 pieces collected in eastern Texas and western Louisiana will be kept in the mammoth Vehicle Assembly Building at the space center, where 6,800 square feet (632 square meters) of office space has been cleared on the 16th floor. A NASA official said the idea was to create a "library" setting for Columbia rather than a grave site. "The debris will be available to scientists and researchers for study. That research, we hope, will lead to better vehicles in the future," said Scott Thurston, the Columbia vehicle manager before the disaster and now the official in charge of storing it. Workers at Kennedy Space Center lobbied NASA to find a more useful and fitting future for Columbia, the world's first reusable spacecraft when it was launched in 1981. "We still consider Columbia to be part of our fleet, just like the other three orbiters. This way it remains useful; its mission continues," Thurston said Thursday. Columbia offers aerospace designers a unique opportunity to study materials exposed to the catastrophic environment of a breakup while traveling at 20 times the speed of sound in temperatures that reached 3000 degrees Fahrenheit. Some of the pieces are as small as bolts, but included are large pieces such as the front landing gear, the windows used by the commander and pilot and two airlock hatches. NASA said the crew compartment, which was never shown to the public during the investigation, will also be available for study, but the families of the seven astronauts who died would be consulted before those pieces are sent to laboratories. The debris has been spread out in a hangar while the crash was investigated. The Columbia Accident Investigation board released its report last month, saying an impact with foam that broke off the external fuel tank shortly after launch smashed a hole in the left wing, allowing super-hot gasses to enter the wing and melt the aluminum frame. Web posted. (2003). [Shuttle wreckage headed for 'library' [Online]. Available WWW: <http://www.cnn.com/> [2003, September 12].]

September 15: The final report of the Columbia Accident Investigation Board (CAIB) should have taken a stronger stand on the need for measures to increase the survivability of space shuttle crews, according to a board member who has written a supplemental document. Air Force Brig. Gen. Duane Deal wrote in his supplement, which has not been publicly released yet, that the CAIB report provided only one "observation" and no recommendations on crew survivability, even though there are indications that improvements could be made in that area. For instance, the board received evidence that adding a small amount of insulation around the crew cabin "might provide the thermal protection needed for the cabin to retain its structural integrity in certain extreme situations," Deal said. "To enhance the likelihood of crew survivability, NASA must evaluate the feasibility of improvements to protect the crew cabin of existing orbiters," Deal's recommendation says. Elsewhere in the report, Deal said the CAIB should have offered stronger language on orbiter corrosion. He recommended that NASA develop non-destructive inspections to detect hidden corrosion. Deal also called for reinstating safety standards that were waived for the attach ring for the solid rocket booster and external tank. As things stand now, there is a "potential danger of this system experiencing a failure," he said. Web posted. (2003). [Expert warns of future shuttle woes [Online]. Available WWW: <http://msnbc.msn.com/> [2003, September 15.]

September 16: NASA might never figure out a way to repair the type of serious wing damage that doomed Columbia's seven astronauts despite an accident board recommendation to do so, agency officials said Tuesday. And while the agency fully intends to provide a way for astronauts to make orbital repairs to shuttle thermal tiles and wing panels, the latter is proving to be one of the biggest technical challenges facing NASA. "It's not out of the realm of possibility that we will develop that capability," NASA flight director Paul Hill said during a series of briefings in Houston. But Steve Poulos, manager of NASA's Orbiter Projects Office at Johnson Space Center, added the agency is uncertain how much wing panel damage future crews might be able to fix. "What level of damage we can repair is a question," Poulos said. And if engineers can't come up with a way to fix that type of damage, then NASA "will have some decision points that we as an agency need to sit down and talk about and decide if that's a risk we're willing to take," he said. Accident investigators traced the Feb. 1 Columbia disaster to a fatal breach in one of the composite carbon panels that served as thermal armor for the shuttle's left wing. Created by a deadly strike from a piece of external tank foam debris, the breach was characterized by investigators as a 6- to 10-inch hole that allowed hot gasses to enter the wing and tear apart the ship. In a stinging Aug. 26 report, the investigators recommended that NASA "develop a practicable capability to inspect and effect emergency repairs to the widest possible range of damage." And they ordered NASA to do so before shuttles return to flight. Hill said NASA is making progress on coming up with a way to fix damaged tiles based on preliminary work done in the late 1970s. NASA at that time tried to develop a tile repair kit. The initial plan is to have spacewalking astronauts use a caulking gun to fill damaged tiles with a material that can withstand the heat of re-entry. A separate bid to develop a means to repair wing panels has shown some promise for fixing holes that range up to 4 inches in diameter, Poulos said. But it's questionable whether astronauts can patch larger breaches, he added. The main challenges: Coming up with a material that can stick to the Reinforced Carbon Carbon wing panels and still withstand temperatures up to 3,000 degrees Fahrenheit. Web posted. (2003). [Crews might be unable to fix major wing damage [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 16.]

◆ NASA's first post-Columbia shuttle flight might not launch until mid-summer or later to give the agency time to make changes recommended by an accident board and ensure Atlantis is safe to fly, officials said Tuesday. Moreover, the next two shuttle flights likely will be dedicated primarily to testing new orbital inspection and repair techniques rather than ferrying fresh crews to, or resuming construction of, the International Space Station, officials said. "We've got to take this slow and easy. We need to understand what we're doing and how we're doing it before we go into some of these more complex station missions," NASA shuttle program manager William Parsons said during a series of briefings at Johnson Space Center in Houston. NASA last week said the next shuttle flight largely would be a developmental test run. Parsons now says NASA probably will stage two such missions. The idea, he added, is to make certain the agency is comfortable with new shuttle inspection and repair techniques before taking on seven daunting construction missions still required to complete the unfinished station. Now four months into his new job, Parsons said NASA no longer considers plans to return the shuttle to flight next March as viable. Web posted. (2003). [NASA may push return to flight to May-August [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 16.]

◆ In the coming weeks, NASA managers hope to establish a new target launch date for the resumption of space shuttle missions after they acknowledged Tuesday that a mid-March liftoff wasn't plausible. While recently laying out its return-to-flight game plan, NASA said shuttle Atlantis could be launched as soon as March 11, 2004. But the space agency came under fire from lawmakers in Washington for a perceived belief -- correctly or not -- that shuttles were being rushed back into action. Shuttle program manager Bill Parsons told reporters here Tuesday that the winged space planes wouldn't fly in March or April, and said NASA leaders will meet early next month to select the new target. "Over the next couple of weeks we will be putting together all the rationale of when a good launch date might be appropriate. Right now, we are looking at all the different pieces of hardware that has to be developed, the different things we have to do," Parsons said. The next available launch opportunity extends from approximately May 19 to June 28. By launching during that period, Atlantis will make its ascent and separate from the external tank in daylight. As part of the return-to-flight philosophy, engineers want the best possible photographic coverage of the shuttle and jettisoned tank to look for any debris shed from the tank during the climb to orbit. Another daylight launch period extends from approximately July 18 to August 26. Atlantis' mission -- STS-114 -- was originally envisioned to launch about one month after Columbia's landing to ferry a new resident

crew to the International Space Station. Columbia's tragic disintegration in the skies over Texas on February 1 changed all of that. Officials said Tuesday that Atlantis' mission was being revamped to only deliver critical supplies to the station, allow the astronauts to test shuttle inspection techniques and practice repairing thermal protection tiles during a spacewalk in the orbiter's payload bay. Atlantis' four-person crew -- commander Eileen Collins, pilot Jim Kelly and mission specialists Stephen Robinson and Soichi Noguchi -- likely will receive two or three new crew mates to help with the flight's busy workload. "The crew size and make up is being discussed," said Parsons. "We know there won't be a crew rotation on the next mission. So that is out. We also know it takes at least six crew members to do all things that we need to do safely." NASA is also considering adding another shuttle test flight that would be inserted into the schedule following STS-114 and before station construction activities resume on STS-115 with the delivery of a massive, 35,000-pound solar array truss structure. The extra flight, while conducting more shuttle test objectives, also would complete station tasks deferred from STS-114 and accomplish some "get-ahead" work slated for the logistics and crew rotation flight of STS-116, officials said. "We've got to take this slow and easy. We need to understand what we're doing and how we're doing it before we go into some of these more complex station missions," said Parsons. Station program manager Bill Gerstenmaier indicated that both STS-114 and the potential new flight -- pending final approval -- will carry Italian-built cargo modules. The so-called Multipurpose Logistics Modules are launched in the shuttles' payload bays and then mounted to the station to deliver supplies, hardware and experiments to the outpost. The reusable modules are brought back to Earth by the shuttle. Starting significantly grow the station and finish the U.S. core of the complex. Building the station in space had progressed remarkably well over the past couple of years without any major hiccups. Prior to the Columbia accident, that "U.S. core complete" status was expected in February 2004 with the launch of the Node 2 module. Gerstenmaier said the final push to finish the station was ready to begin once Columbia returned home from its 16-day science mission -- a rare non-station mission by the shuttle. "As a program manager, I likened it to an athlete that was trained for a marathon. We were as poised at the beginning 2003 as we could ever be for this period of assembly. We had the right consumables on orbit, we had the ground teams trained, we had the hardware ready to go fly. We were ready, really ready. We were at our peak performance. "Now, we are not executing and in this hold mode. So how do you keep that same level of preparedness during this expended with the solar array mission of STS-115, a half-dozen shuttle flights are planned to period of time? What we have doing now is just backed off a little bit. We will pick the right point, once we are ready to get back into the assembly sequence, and we will start that building up again and honing to get ready to execute. "That is why I think it is very helpful to get these two shuttle test flights that are more geared to shuttle than station. That gives us a chance to get back in the groove, get back into the assembly sequence. My challenge is how do we get ready to get back into assembly again when we don't know when that will be?" Web posted. (2003). [NASA Managers re-think next shuttle launch date [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, September 16.]

◆ President Bush said he is awaiting a report from a White House advisory group before deciding whether the administration will set new goals for the space program in the wake of the Columbia shuttle tragedy. "I support NASA," Bush told reporters Tuesday. "I want NASA's missions to continue, and we've got an interagency study going on now that will enlighten us to the best recommendations necessary for NASA to proceed in a way that's the best use of taxpayer money." Bush said he did not have a timetable for the interagency advisory panel but he would like to hear from them "sooner rather than later." It has been speculated Bush may make a major space policy announcement in next year's State of the Union speech. But Tuesday, there was a hint the president may choose a different forum. ["Bush wants panel's advice before setting space goals," **Florida Today**, September 17, 2003, p 8A.]

September 17: NASA announced today the selection of InDyne, Inc. of McLean, Va., as prime contractor for its Kennedy Integrated Communication Services (KICS) contract. Total estimated value of the contract is approximately \$190.7 million. InDyne will provide communications services at Kennedy Space Center (KSC), Fla., in support of the Space Shuttle Program, International Space Station Program, Payload Carriers Program and Launch Services Program Office Payloads. Under the cost-plus-award fee/firm fixed price, indefinite delivery/indefinite quantity contract, InDyne will also provide center-wide business engineering logistics, facilities management, hardware and software integration and development for voice, video and data communications. The KICS contract, with a period of performance of approximately five years, is a small business set-aside and the first of the five work packages contained in the Space Mission

Communications and Data Services (SMCDS) solicitation. SMCDS will succeed the current NASA Consolidated Space Operations Contract (CSOC). KICS will also incorporate the requirements from the Visual Information Technical Contract (VITC), and the telephone service requirements of the Outsourcing Desktop Initiative for NASA (ODIN). Other members of the InDyne, Inc. team include telecom affiliate Verizon Federal, Inc. of Washington and subcontractor Northrop Grumman Technical Services of Herndon, Va. ["First Contract in SMCDS Solicitation Awarded to InDyne, Inc," **NASA News Release #c03-ff**, September 17, 2003.]

◆ The Multi-Element Integrated Test (MEIT) between the Japanese Experiment Module-Pressurized Module (JEM-PM) Kibo, and NASA's Node-2 began Aug. 26 and was successfully completed last week at Kennedy Space Center (KSC), Fla. The MEIT performed testing of the International Space Station (ISS) element interfaces to be utilized on Node-2 beginning with the JEM-PM mission. The testing included both the Node-2 and JEM-PM emulation of the ISS on-orbit activation sequence, command and track systems that support audio and video systems on-orbit, and the caution and warning systems that monitor life-support systems in the modules. "The successful completion of the MEIT is a major milestone, successfully demonstrating on-orbit performance of key Station elements on the ground," said Tip Talone, director of International Space Station and Payload Processing at KSC. "The team did a superior job." The complexity of the MEIT, only the third integrated test of its kind to be performed at KSC, required assembly of an international and multi-organizational team. The team included members of the European Space Agency, the National Space Development Agency of Japan, the Canadian Space Agency, the Italian Space Agency, and NASA and Boeing employees at KSC; Marshall Space Flight Center, Huntsville, Ala.; Glenn Research Center, Cleveland; Johnson Space Center, Houston; and Dryden Flight Research Center, Edwards, Calif. Flight crew members from the United States, Japan and Brazil also came to KSC to assist in testing. Upon delivery to the Station, Node-2 will be attached to the U.S. Lab Destiny, and JEM-PM will subsequently be attached to Node-2. . ["Space Station Elements Successfully Complete Testing," **NASA News Release #03-298**, September 17, 2003.]

◆ NASA will have to fly its first post-Columbia shuttle mission by mid-October 2004 or face a potential delay of 4½ months because of new rules on acceptable lighting conditions during launch, officials said Wednesday. The new rules effectively will prohibit NASA from launching shuttle missions during about six months of every year, a fact that will limit the agency's ability to complete construction of the International Space Station. Senior shuttle managers, however, insist that the restrictions will not create the type of schedule pressure that contributed to both the Feb. 1 Columbia disaster and the 1986 Challenger explosion. In both cases, investigators found that NASA allowed pressure to maintain ambitious launch schedules override safety concerns that ultimately doomed seven-member astronaut crews. "We have to guard against that, and it's going to be hard," John Shannon, NASA's manager for flight operations and integration, told reporters during a series of briefings at Johnson Space Center. "But that's not the way we're going to operate." Almost all shuttle launches for the foreseeable future will be missions to the international station, including two developmental test runs NASA aims to fly before resuming construction of the unfinished outpost. Launches to the station already were limited to time periods when a shuttle docked to the outpost would not be exposed to sunlight more than 72 percent of each orbit. The concern is that extremely hot temperatures could foul shuttle systems. New post-Columbia rules now dictate that shuttles be launched during daylight so that the agency can photographically document the ship's external tank in flight so any breakaway foam insulation can be detected. For the same reason, launches also must take place during times when the shuttle's external tank is jettisoned on the sunlit side of Earth. The idea is to be able to spot any missing foam insulation as the 15-story fuel reservoir falls away from the shuttle. In 2004, NASA effectively will be limited to launching during four time periods: roughly March 11 to April 6; May 19 to June 28; July 18 to Aug. 26 and about a three-week period between mid-September and mid-October. Two three-day launch opportunities exist in November 2004 and January 2005, respectively. But NASA would be unable to launch in late October and November 2004 as well as much of January, February and March 2005. Where shuttles will land in the future also is in question. Preliminary results show that the risks to the public are about equal when it comes to landing at Kennedy Space Center, Edwards Air Force Base or White Sands Space Harbor in New Mexico, Oliver said. Further analysis, however, will be needed to determine exactly where NASA will send shuttles for future landings. Web posted. (2003). [New rules limit shuttle launch opportunities [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 17.]

◆ In perhaps the most convincing demonstration yet that NASA "gets it," the new chairman of the agency's mission management team today outlined major changes to improve communications among engineers and managers, to ensure dissenting views are heard and to correct the cultural shortcomings blamed in part for the Columbia disaster. "Any arrogance I may have had went out the window on Feb. 1," said Wayne Hale, a widely respected ascent-entry flight director who brings calm credibility to the mission management team. "In my personal life, before February I thought we had it pretty much knocked. ... I would have told you we understood what we were doing and we had mature processes and good hardware. And I think all of those assumptions have been shattered." As chairman of the revamped mission management team, Hale will oversee the conduct of all phases of flight, from the pre-launch review needed to clear a shuttle for launch to the in-flight management of its mission. At a news conference, Hale unveiled an ambitious plan to resolve shortcomings found by the Columbia Accident Investigation Board as well as issues identified by NASA personnel in the wake of the accident. New members will be added to the MMT, outside experts will be brought in to coach the managers on decision making skills and regular mission simulations will be held to test those skills in make-believe emergencies. Some agency veterans have criticized the new MMT plan, saying the additional voices and opinions will make it more difficult to make a final decision. But Hale disagrees. "I am convinced that we not only should, but must, come to an understanding of why it's OK to proceed in the face of a minority opinion," he said. "My basic model is consensus. We will bring the person from the organization that's got the concern and we should be able to demonstrate in a technical, analytical, engineering sense why it's safe to proceed or we shouldn't proceed. I don't know any other way to do that. The Columbia Accident Investigation Board was sharply critical of MMT operations during Columbia's ill-fated mission. Contrary to NASA's own rules, the MMT, under chairman Linda Ham, did not meet every day and did not seriously debate the results of a hurried analysis that mistakenly concluded Columbia was not seriously damaged by a foam debris strike during launch. Despite an almost complete lack of hard data about the possible threat posed by the strike, the MMT quashed efforts by lower-level engineers to obtain spy satellite imagery that might have revealed the extent of the damage. Hale today vowed to learn from the mistakes of the past. And he left little doubt he believes the management culture at NASA needs to change. "I have to say, STS-107, the Columbia flight, has been a significant emotional event in my life and I think in the life of everyone in the agency, certainly in the shuttle part of the agency," he said. "We had many of our assumptions and concerns shattered on Feb. 1. An internal review of the new MMT plan will be complete by Oct. 2. By the middle of the month, all MMT members will attend a class defining the precise roles and responsibilities of panel members. By the first week in November, the MMT will participate in a so-called "warm-up" simulation, the first in a series of regularly scheduled simulations to test MMT decision-making skills. Web posted. (2003). [Shuttle mission management team gets major revamp [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, September 17.]

September 20: The people who put the space shuttles together said errors are inevitable, but their work process gives them time to catch mistakes. The Columbia Accident Investigation Board's report complained there were too many "diving catches" of last-minute problems at Kennedy Space Center that "pose serious hazards to shuttle safety," but workers from chief shuttle contractor United Space Alliance said dedicated, experienced employees find problems when they should. A handful of USA employees shared stories recently of how they called a "time out," stopping shuttle work to deal with safety concerns. "A lot of the critical items that we're concerned about are all as you're going along in the processing, so there's plenty of time to catch problems," Barbara Kennedy said. Even if there isn't much time, workers are trained to act on the side of safety, she said. She was a ground launch sequencer engineer in 1999 when she stopped a countdown a couple of seconds before the engines were to start, after a high hydrogen reading was seen in the aft of Columbia. In other instances, one worker found a crack in a fuel-pipe liner that prompted the grounding of the shuttle fleet for months. Two saw platforms out of place that could have damaged a shuttle while it was being moved. One stopped a potentially damaging test on a piece of shuttle hardware. In each case, they said, managers supported their actions. "I was working software changes for the ground launch sequencer, and that's a very critical software system where everything just has to be perfect," Kennedy said of the July 1999 launch of Columbia. The ground launch sequencer controls commands to the shuttle in the last minutes of the countdown. Moments before launch, the operator of the hazardous gas console saw what turned out to be false readings indicating a high level of hydrogen. "It was very late in the count at 8 seconds, and the engines start at 6.6," Kennedy said, "and they felt uncomfortable with the

situation. They asked for a cutoff from the ground launch sequencer." She pushed the button. "I was prepared to perform, although I never thought it would happen," Kennedy said. "I didn't hesitate, and I didn't think of the repercussions of it. I did what I had to do." Todd Reeves is a shop lead in the Vehicle Assembly Building, where the shuttle's solid rocket motors and external tank are processed before launch. Calling a time out is expected when a worker thinks something isn't right, he said. "From the lowliest technician that's been here a month, to somebody like myself that's been here 22 years and even longer, it's an expectation, and you count on it," he said. He once saw a lift on a platform in the wrong position during the mating of the external tank to the orbiter. His "time out" stopped the process until it could be fixed. "Had it not been caught, it was a possibility we could have damaged flight hardware severely," Reeves said. The Columbia Accident Investigation Board reserved much of its criticism of Kennedy Space Center operations for the quality assurance program, saying that inspections are inadequate. It also said that inspectors are discouraged from rejecting the work of contractors and that problems aren't tracked in an easily accessible database. On the worker level, though, the CAIB report said "time out" and similar programs helped make industrial safety "vibrant" and "highly visible." Time out cards are issued to employees by USA, and they make it easier to speak up about problems, Kennedy said. "It works well," Reeves said. He's slammed a card down on a table to make a point, and he's whispered concerns to a supervisor. Either way, people listen, he said. Web posted. (2003). [Space Alliance defends work [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 20.]

September 21: NASA plunged the Galileo spacecraft into Jupiter's turbulent atmosphere today, bringing a fiery conclusion to a 14-year, \$1.5 billion mission. The unmanned spacecraft, traveling at nearly 108,000 miles per hour, was torn apart by the heat and friction of its fall through the clouds after it dived into the atmosphere at 2:57 p.m. Eastern time. Web posted. (2003). [Jupiter Probe Ends Mission After 14 Years [Online]. Available WWW: <http://www.nytimes.com/> [2003, September 21.]

September 23: NASA Administrator Sean O'Keefe yesterday found himself with an unexpectedly blank slate as he sets out to revamp the agency's much-criticized safety apparatus, after all nine members of a key oversight panel resigned. NASA was unprepared to discuss how it might reorder its suddenly vanished Aerospace Safety Advisory Panel, whose operation was criticized as ineffective in the aftermath of the Feb. 1 Columbia accident. In a statement yesterday, O'Keefe said only, "It's evident that a wide range of oversight functions should be strengthened within the agency. We need to take this opportunity to explore how the original concept for [the panel] needs to evolve." The nine aerospace experts on the advisory body said they and two staff members had privately reached the decision to quit to clear the way for O'Keefe to make the panel more effective, as called for by the Columbia Accident Investigation Board and key congressional committees following the loss of the space shuttle Columbia. O'Keefe had also made negative comments about the panel. "This will give you and the Congress the freedom to revitalize the panel and reshape its charter and mission," wrote software engineer Shirley C. McCarty, chairman of the group, in her resignation letter. The panel was formed after the 1967 fire that killed three Apollo astronauts on the launch pad, the first major tragedy to strike America's human space flight program. Some panel members, expressing frustration, said subsequent legislation weakened its authority. ["NASA Oversight Panelists Resign," **Washington Post**, September 24, 2003, p A03.]

◆ NASA's next manned space vehicle will have a more capable crew escape system than shuttles and will provide for a quick emergency return to Earth from the International Space Station, officials said Tuesday. The Orbital Space Plane, however, will lack the cargo capacity of the more versatile shuttles and will not provide a platform for station maintenance or satellite deployment and repair work. Instead, a review of system requirements released by NASA show the vehicle primarily will be designed to serve as a less expensive way to launch astronauts to – and rescue them from – the international outpost. "This review is a critical step in making the Orbital Space Plane a reality," NASA program manager Dennis Smith said in a statement. "These requirements are the instruction manual for designing the entire system that will provide safe, reliable access to and from the International Space Station." The review focuses sharply on a crew's ability to survive during a launch countdown and flight to and from the station. The vehicle must be safe enough that no two systems failures can "result in permanent disability or loss of life," the review said. A risk analysis done as part of the review showed that the space plane likely would be required for at least one rescue mission every four years. The space plane's escape system will be designed to provide "a means for the crew to leave a vehicle in distress during some or all of its flight phases and

return safely to Earth," the review said. ["NASA decides goals for new space plane," **Florida Today**, September 24, 2003, p 2A.]

September 25: A who's who of space history has walked through the white room from Launch Complex 19. Armstrong, Cernan, Borman, Schirra, Grissom. All of them, and more, were ushered through the 56-foot-tall structure into two-man Gemini capsules in the mid-1960s. On Wednesday, the restored 46-ton structure was itself moved -- about 1,800 feet -- from a restoration area to the display area of the Air Force Space and Missile Museum at Cape Canaveral Air Station. With cranes and crawlers doing the heavy lifting, the trip took about 20 minutes at roughly 5 mph, director Emily Perry said. "There's still some work to be done, but it's there for people to see," she said, adding other museum presentations remain to be finished on the white room's history and significance to the Space Race of the 1960s. The red structure -- it's white on the inside -- once stood alongside Gemini rockets, providing an environmentally white area for astronauts to pass through on their way into space. The five-story high hulk also was outfitted with a crane to hoist capsules atop their booster rockets. After Complex 19 was deactivated in 1967, the white room fell into disrepair with remainder of the pad area. In 1998, the museum operators requested the white room from state historic authorities on the condition it would be restored. The five-year effort to replace windows, doors, wiring, hazardous components, sandblast, wash, prime and paint is complete. Located in a restricted area, the general public can get there only by visiting the Kennedy Space Center Visitor Complex and taking the "Now and Then" tour. Personnel with 45th Space Wing credentials or others with access to the Space Center and air station have it easier and can go there directly. Web posted. (2003). [Gemini-era 'white room' moves to museum [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 25.]

September 27: Extensive factory inspections of wing panels between flights could add as much as three months to the time it takes to prepare a space shuttle orbiter for launch, NASA and contractor engineers said Friday. But in response to the Feb. 1 Columbia disaster, the agency is trying to develop techniques that could enable inspections to be performed at Kennedy Space Center. And that capability might negate the need to send panels to their manufacturer in Texas after every flight. "We're in the infancy of that," NASA vehicle manager Scott Thurston said. The exact scope of inspections that will be required between missions after NASA returns its shuttle fleet to flight is undecided, Thurston said. Shipping them back to the factory would extend the time it takes to prepare a shuttle for launch from four to seven months, he added. And at least for now, that's the plan. "Right now, on the books, the way we'll do this is pull (wing panels) off every time, between every mission," Thurston said. The Columbia disaster was traced to a wing panel breach that enabled hot gasses to tear the ship apart during an ill-fated atmospheric re-entry. Accident investigators found periodic visual inspections and "touch tests" done at KSC between flights were not adequate to gauge the structural integrity of the shuttle's reinforced carbon carbon panels. The investigators recommended NASA "develop and implement a comprehensive inspection plan to determine the structural integrity" of the panels, taking advantage of advanced non-destructive inspection technology in doing so. As part of its effort to return the shuttle fleet to flight, NASA plans to send all wing panels from its three remaining orbiters -- Atlantis, Discovery and Endeavour -- back to manufacturer Lockheed Martin in Grand Prairie, Texas. Once there, the panels will be subjected to ultrasound, X-ray and eddy current inspections to detect any defects. Web posted. (2003). [NASA wants to inspect wing panels at KSC [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 27.]

September 28: Two members of an independent task force overseeing NASA's effort to implement sweeping changes recommended by Columbia accident investigators resigned last week, a spokesman for the group said Saturday. Retired Air Force Maj. Gen. Ralph Jacobson, who led a task force watching over NASA managerial changes, left for personal reasons, as did David Raspet, an engineering consultant and expert on national-security space systems. David Drachlis, a spokesman for the Stafford-Covey Return to Flight Task Force, said the departures are not expected to affect work being done by the group, which has 28 members. Personnel changes in a group that large are not unusual, he said. Neither Jacobson nor Raspet could be reached for comment. Dan Crippen, former director of the Congressional Budget Office, will lead the task force watching over NASA managerial changes, Drachlis said. Web posted. (2003). [NASA Task Force members resign [Online]. Available WWW: <http://www.floridatoday.com/> [2003, September 28.]

September 29: Kennedy Space Center's new director has spent years managing the complicated machines of the shuttle program. Yet Jim Kennedy's greatest gift may be the way he deals with colleagues, those who know him say. Those people skills may matter now more than ever. Kennedy must lead the shuttles back to space following the shuttle Columbia disaster. He is under tremendous pressure at a critical crossroads for NASA, but he's thrilled to be back in the place where he grew up. "As much as I loved being a project manager, I've never loved a job like I love this job. Now, that may come to a screeching halt when you've got to take off the gloves," he said with a chuckle. "KSC excites me, just to be a part of the Kennedy Space Center." Space has always excited Kennedy, who was born in Maryland. His family moved to the Space Coast in the 1950s, when there was so little housing that they first had to stay at Patrick Air Force Base. His father, like so many of his friends' parents, worked in the space program. He was immersed in anticipation as the first astronauts lined up to fly into space. "You just can't grow up in this environment, especially in the '60s, and not have it get in your blood," Kennedy said. Initially, NASA planned 60 shuttle flights a year, a fourth of them from California. Kennedy's first job was to assess what it would take to ramp up to 100 flights a year, he said, a number that seems staggeringly unrealistic today. "Does that show how naive we were?" he said. Kennedy's style is very different from that of his predecessor, Roy Bridges Jr., now director of NASA Langley Research Center. Bridges was more introverted, and as a retired Air Force major general, his military background was evident in his leadership style, said Bruce Melnick, Boeing's vice president for Florida operations and a former astronaut, who has known Kennedy for about 10 years. Kennedy, who was deputy director to Bridges for several months before taking the director's job, is more outgoing, his humor less dry. The management shifts across the space agency are part of Administrator Sean O'Keefe's "one NASA" push, in which Kennedy strongly believes. He said an important criticism in the Columbia Accident Investigation Board report is connected "to the fear that people can't speak up, that they worry people will be criticized or punished, some sort of reprisal," he said. "Life's so crazy out here," he said of KSC. But he's made himself at home in the big executive office, where he has plans to install the telescope former director Kurt Debus once used there. ["Kennedy's space center rebuilding dreams, trust," **Florida Today**, September 29, 2003, p 1A & 2A.]

During September: Two members of NASA's Aerospace Safety Advisory Panel (ASAP) who resigned in the face of criticism from the Columbia Accident Investigation Board will continue as members of the task force overseeing how well NASA meets the accident board recommendations. The board questioned the independence of the ASAP, which was created after the January 1967 Apollo 1 fire, noting that its support staff "generally consists of full-time NASA employees." The panel and its consultants resigned after its September meeting so Congress and Administrator Sean O'Keefe would have "the freedom to revitalize the panel and reshape its charter and mission." But retired USAF Lt. Gen. Forrest S. McCartney, a former director of Kennedy Space Center, and Robert B. Sieck, former director of shuttle processing at KSC, will continue as key safety advisors in their roles as members of the Return-to-Flight Task Group. Headed by former astronauts Thomas Stafford and Richard O. Covey, the task group will play a key role in advising O'Keefe on when it is safe for shuttle operations to resume. ["Return ASAP," **Aviation Week & Space Technology**, September 29, 2003, p 21.]



Viewed here is part of the tracking telescope that provides optical support for launches from KSC and Cape Canaveral. The telescope is part of the Distant Object Attitude Measurement System (DOAMS), which includes improved tracking cameras and long-range optical tracking systems that will be used to capture ascent imagery during the return to flight of the Space Shuttle.

OCTOBER

October 1: What's the next drama in store for the international space station, where a member of the current crew became the first man to marry while in orbit? Not a divorce, the American commander of the three-nation crew said. Michael Foale, commander of the mission scheduled to begin with a launch from the Baikonur Cosmodrome in Kazakhstan on October 18, said neither he nor either of his two crew members intends to tie -- or untie -- the knot from aboard the space station. "We do not plan to do any new marriages or divorces in space," Foale said after a news conference Tuesday at Russia's Star City cosmonaut training center outside Moscow. "We are a very boring crew in that regard." Foale's team includes Russian cosmonaut Alexander Kaleri, who will command the Soyuz spaceship on the voyage to the station, and European Space Agency astronaut Pedro Duque of Spain. All three men are married with children. Web posted. (2003). [New ISS skipper: no more space weddings [Online]. Available WWW: <http://www.cnn.com/> [2003, October 1].]

◆ NASA is set to push its first post-Columbia shuttle launch back to mid-July, but work to make certain Atlantis is safe to fly could ultimately prompt a delay until next September or later. Senior NASA officials will meet Friday and consider whether to move the planning date for the Atlantis flight to July 15 from a date between March 11 and April 6. New on NASA's list of potential work to do: inspections on the nose cap of Atlantis, which is made of the same composite carbon material as shuttle wing panels. NASA and contractor officials are reviewing records to determine whether the nose cap was inspected in its last major structural inspection in 2001. A decision will be made on what type of inspection should be performed on the nose cap, and where those inspections should be done. NASA ultimately could send the nose cap back to its Texas manufacturer. It's not clear whether that work could be finished in time to launch in mid-July. ["Atlantis may not launch for year," **Florida Today**, October 2, 2003, p 1A & 2A.]

◆ The top Democrat on the House Science Committee introduced legislation Wednesday that would create an independent panel to keep long-term tabs on NASA's response to the loss of the space shuttle Columbia. Rep. Ralph Hall, D-Texas, wants the National Academy of Sciences and the National Academy of Engineering to appoint a committee after the next shuttle flight to ensure NASA continues to comply with the recommendations made by the board that investigated the Feb. 1 accident. NASA already has appointed a task force, led by former astronauts Thomas Stafford and Richard Covey, to help the agency meet the Columbia accident Investigation Board's recommendations. The task force is chartered for two years but is expected to break up after issuing its report about a month before the next launch. But Hall wants to ensure that NASA's commitment doesn't wane after the first shuttle flight. In its report released in August, the Columbia board said NASA's safety culture had slowly eroded since the 1986 Challenger explosion that killed seven astronauts. The board's leader, retired Adm. Harold Gehman, has expressed concern that the same thing could happen again without stronger, long-term oversight. Hall's bill would activate the national academies' committee after the Stafford-Covey panel disbands, and keep it in place for at least six years, reporting regularly to NASA and Congress. ["Lawmaker proposes watchdogs for NASA," **Orlando Sentinel**, October 2, 2003, p A10.]

October 3: About a dozen former members of NASA's Aerospace Safety Advisory Panel charged this week that Congress, the White House and agency officials still are not addressing long-standing budget deficiencies that contributed to the Columbia shuttle disaster and could result in future accidents. The engineering and aerospace experts also complained that they were peremptorily dismissed by NASA or forced to resign after previous efforts to highlight the inadequacy of shuttle funding and its potential safety consequences. "Rather than committing to an adequate budget for the space shuttle, NASA and its congressional allies found it easier to get rid of those raising the alarm," the former panel members said in a statement provided to *The Washington Post*. The harshly worded statement marks an escalation in tensions between NASA and the former panel members, who complained about their lack of influence and what they termed "unfair and irresponsible" criticism of the performance by members of Congress, NASA and the Columbia Accident Board following the Feb. 1 shuttle accident. The former panel members said that for the past five years, during the Clinton and Bush administrations, they warned the shuttle budget and personnel cutbacks were excessive and eroding safety margins. They said they were "particularly ignored"

by NASA when they urged costly upgrades of hardware and space center infrastructure. ["Tension between ex-panel members, NASA escalating," **Florida Today**, October 4, 2003, p 5A.]

◆ The space shuttle's return to flight will not happen before at least mid-September of next year, NASA officials said Friday, and even that date remains uncertain. William Readdy, NASA's top spaceflight official, and shuttle program member William Parsons said after a meeting Friday that the earliest window for a launch is now targeted between Sept. 12 and Oct. 10, 2004. An earlier working target window of mid-March to mid-April, they said, has been discarded because the agency is gaining a better sense of how long the necessary safety changes for the shuttle will take. Readdy and Parsons emphasized that the new dates are really for planning purposes – not a guarantee – and could change if some of the work takes longer than expected. If NASA can make the earlier launch window, the target date for the next shuttle flight is Nov. 15. That mission has been added as a second test flight before the focus returns to construction of the international space station resumes. However, NASA's new mandate that launches happen only in daylight, in combination with a host of other constraints, affords the agency few opportunities between mid-October 2004 and mid-March 2005. ["NASA pushes back shuttle's next launch," **Orlando Sentinel**, October 4, 2003, p A7.]

October 4: This weekend, Merritt Island National Wildlife Refuge celebrates four decades of wildlife protection around Kennedy Space Center. The 140,000 acres NASA set aside as a buffer for rocket launches has become proof to many that high-tech and wildlife can coexist. Karl Eichhorn, 79, of Cocoa Beach has known about the lush bird life since the days when NASA agreed to create the refuge in 1963. Between the 1960s and early 1970s, NASA turned over areas not in use to the Fish and Wildlife Service. NASA bought the land for more launch pads that never materialized. Over the years, naturalist Allan Cruickshank, who worked for the Audubon Society, prodded NASA officials to let the U.S. Fish and Wildlife Service take over managing the lands. Public pressure mounted to allow access to hunters and fisherman. George Diller, a NASA spokesman, said the arrangement has worked well. "It's worked extremely well. I think as far as NASA's concerned, we needed someone to help us with the stewardship of this land," Diller said. Cruickshank died in 1974. Ten years later, the refuge named its main birding trail after him. In its 40 years, the refuge has become a vital habitat for migratory birds, bobcats, Florida scrub jays and gopher tortoises. More than 500 species live on the land and surrounding estuary, including at least 15 federally listed as endangered or threatened, such as the Indigo snake and the manatee. ["40 years of refuge," **Florida Today**, October 5, 2003, p 1A & 10A-11A.]

October 6: With a pair of Air Force locomotives pushing the way, Cape Canaveral's penultimate Titan 4 rocket was rolled from its assembly building to the launch pad Monday where it will undergo four months of work before hauling a missile-warning satellite into space. Standing about 120 feet tall on its mobile launching platform, the "headless" rocket was backed out of the Solid Motor Assembly and Readiness Facility, or SMARF, for the one-mile trek to the Complex 40 pad. The move represented a key milestone in preparing the Lockheed Martin-built rocket for its U.S. national security mission. But with just two Titan 4 launches remaining at the Florida spaceport, the moment reminded everyone that the heavy-lifting rocket's era is nearing an end. Twenty-five Titan 4 rockets have flown from the Cape since June 1989. The era draws to a close next October when the Titan 4 B-30 mission -- with no upper stage -- lifts off carrying a National Reconnaissance Office cargo. The final Titan 4 mission is scheduled for February 2005 from Vandenberg Air Force Base in California, also loaded with a classified NRO spacecraft. It will mark the 12th Titan 4 launched from the West Coast. Web posted. (2003). [Cape's next-to-last Titan 4 rocket moved to launch pad [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, October 6].]

October 8: A simple foam paint brush that costs only pennies at hardware stores could be an essential tool in returning the shuttle to orbit, NASA's administrator said Wednesday. Space agency engineers found the brush may be just what astronauts need to spread a patching compound on a shuttle's damaged heat shield while the craft is in orbit. "This thing turns out to be one of the most valuable tools we could have invented," said Sean O'Keefe, head of NASA. "We're going to buy it at Wal-Mart. We're not going to ask the Defense Department to requisition it out of stock." A clerk at a Washington-area hardware store said a 1-inch foam brush sells for 49 cents and a 2-inch one costs 99 cents. Designing and testing a way to repair damage in the shuttle's heat shield is an important part of NASA's efforts to return shuttles to space after the Feb. 1 accident that destroyed Columbia and killed seven astronauts. The accident was blamed on a

hole in the left wing that let gases enter the craft during reentry and sear the structure apart. Astronauts on Columbia and engineers in Mission Control were not aware of the extent of damage to the shuttle wing. But officials said that, in any case, there was no equipment on the shuttle to patch the wing even if the problem was recognized. Officials at the Johnson Space Center said the patching compound now under consideration could be used only for the part of the heat shield composed of lightweight tiles. The nose of the shuttle and the leading edge of the wings are covered with panels of a different material, reinforced carbon-carbon. It was a break in a carbon-carbon panel that destroyed Columbia. Kelly Humphries, a spokesman at the space center, said repairing the carbon-carbon panels is more difficult and would require methods different from the tile repair. Among the techniques under consideration are a patch that could be internally bolted in place, an adhesive patch, or an overwrap that would envelop a heat shield breach. Before returning to flight, the investigation board said NASA must develop a way for astronauts to fix heat shield damage while the craft is in orbit. Web posted. (2003). [Brush may repair heat shields [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 8].]

◆ High-flying chase planes, along with enhanced camera and imagery analysis systems, eventually might enable NASA to stage shuttle liftoffs at night again, opening up more chances to launch space station construction missions. That was the word Wednesday as NASA officials at Kennedy Space Center detailed plans to improve the agency's capability to detect and analyze the type of launch debris strike that triggered the Feb. 1 Columbia accident. "We're all looking at how do we support the night launches and step back up to being able to fly at night," said Robert Page, chief of a NASA group responsible for capturing and analyzing shuttle launch film, video and still photographs. The agency is "extremely hopeful" that the improvements would enable NASA to lift new restrictions that limit shuttle launches to daylight hours, he added. The new rules also limit launches to times when the shuttle's 15-story external tank would be jettisoned on the sunlit side of Earth. The restrictions are meant to ensure NASA can capture sharp images of any debris that could break free from the shuttle and damage the ship in flight. But at the same time, they eliminate launch opportunities during six months of every year. That will hinder NASA's efforts to complete construction of the International Space Station, a \$100 billion project that involves 16 nations. Accident investigators blamed the Columbia disaster on a 1.7-pound chunk of foam insulation that fell off the shuttle's external tank 81 seconds after its Jan. 16 launch. The foam struck the leading edge of the shuttle's left wing, creating a fatal breach that allowed hot gases to tear the ship apart during an ill-fated re-entry. Investigators found NASA's analysis of the deadly debris hit was hampered by a lack of high-speed, high-resolution cameras. Among other things, they recommended NASA upgrade its launch imaging system to provide "a minimum of three useful views" of the shuttle from liftoff through separation of its solid rocket boosters two minutes into flight. They ordered NASA to delay future launches if any of those cameras aren't working properly prior to liftoff. And they urged the agency to consider using ships or aircraft to provide additional views of the shuttle as it climbs toward orbit. NASA now is in the midst of upgrading existing ground cameras as well as those that fly aboard shuttles. The agency also plans to add extra cameras on the ground as well as on the shuttle's external tank and solid rocket boosters. For the first time, NASA is adding high-definition television cameras to its network of ground imagery assets. The agency also is opening a new high-tech imagery analysis laboratory. NASA is still assessing how much all the improvements will cost, Page said. But the agency already has invested \$3.2 million in the computerized lab, which will enable engineers to digitize launch film. Doing so will create sharper views as well as the ability to zoom in on images for closer analysis. Lab equipment also provides the capability to simultaneously analyze launch views from different angles. Page said NASA now plans to employ two camera-toting NASA WB-57F aircraft to image the forward portion of the vehicle during the agency's first two post-Columbia missions in September and November 2004. Bright shuttle exhaust plumes during night launches obscure ground camera views of that area of the shuttle, which is the most susceptible to shedding debris in flight. "We'll fly those aircraft up there and see how the images look and see whether that can help us," Page said. "We'll just have to see what the data tells us." . Web posted. (2003). [Upgrades may allow night flights [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 8].]

October 9: NASA Administrator Sean O'Keefe said Wednesday that he plans to reconfigure the Aerospace Safety Advisory Panel – in limbo since its nine members resigned two weeks ago – by getting back to the oversight group's roots. O'Keefe said he envisions the panel, chartered by Congress after the 1967 Apollo 1 launch-pad fire, functioning more as an assessor of big-picture issues rather than focusing on specific incidents. In essence, O'Keefe seemed to suggest that the ASAP behave like a long-term version

of the Columbia Accident Investigation Board, which probed the physical cause of the Feb. 1 demise of the space shuttle Columbia but also highlighted deep-seated cultural problems that lead to the tragedy. "It ought to function more like a committee of a board of directors, if you will, of any company that looks at the systemic, institutional kind of framework you use for the purpose of assuring safety and risk management," O'Keefe said at a meeting with reporters. The ASAP panel, which the Columbia board noted was "often not very influential," has also come under criticism from Congress. All nine members of the panel quit Sept. 22, with several saying that the congressional criticism and NASA's disregard of its recommendations had rendered it meaningless. O'Keefe said he expects to name a new panel soon. Web posted. (2003). [Safety panel should focus on big-picture issues, NASA chief says [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, October 9].]

October 10: Following Thursday's official launch of The Walt Disney Co.'s new \$100 million "Mission: Space" ride at Epcot, those involved in advancing tourism on the Space Coast are hoping for a similar reverberation from the famous theme park. But instead of a shuttle-launch-induced ground tremor, they're hoping more than a few Disney visitors -- after strapping in the gut-churning ride on the shuttle simulator -- will want to learn more about NASA and the nation's storied space program at the KSC Visitor Complex, which is a 40-minute drive from Epcot. Furthermore, they're hoping those same guests, after a trip to KSC, might want to visit one of Brevard County's beaches or eco-tourism destinations. Drawing more visitors to the Space Coast is crucial, since the tourism industry is a major local employer and a stimulus for Brevard's economy. Web posted. (2003). [Brevard hopes Disney's 'Mission: Space' launches a boom in tourism [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 10].]

◆ NASA has modified the Space Flight Operations Contract (SFOC) with United Space Alliance (USA) of Houston for work in support of the Space Shuttle and International Space Station Programs. The contract modification is for the fiscal year 2004 Program Provisioning Task List, a modification negotiated annually to cover special and unique studies, analyses or tasks. This modification does not include Return to Flight efforts. It requires USA to perform several tasks involving Space Shuttle Orbiter and Solid Rocket Booster modification, infrastructure and launch pad refurbishment at NASA's Kennedy Space Center, Fla., and flight operations in support of the Space Shuttle and International Space Station Programs. This effort is cost-reimbursable with award fee. The modification is valued at \$49 million including options. The basic effort is valued at \$45 million, bringing the total value of the SFOC to \$12.8 billion. The work will be performed principally at USA's facilities in Houston; Huntsville, Ala.; the Kennedy Space Center; and the major subcontractors' facilities in Huntington Beach, Calif.; Houston; and Cape Canaveral, Fla. ["NASA Modifies Space Flight Operations Contract," **NASA News Release #c03-MM**, October 10, 2003.]

◆ NASA announced today Dr. Steven J. Dick is the new Director, History Office, and Chief Historian. Dick has worked as an astronomer and historian of science at the U. S. Naval Observatory since 1979. He obtained his Bachelor of Science in astrophysics (1971), Master of Arts and Ph.D. (1977) in history and philosophy of science from Indiana University. He fills the position that has been vacant since Dr. Roger D. Launius departed in July 2002 to become historian of the National Air and Space Museum. ["NASA Names New Historian," **NASA News Release #03-327**, October 10, 2003.]

October 14: A spacecraft dubbed the Divine Vessel and its lone astronaut blasted off from a remote Gobi desert location early today, catapulting China into the elite club of nations that have sent a human into space. By sending its taikonaut -- the Chinese work for astronaut -- Yang Liwei into orbit, China joined United States and the former Soviet Union as the only countries to successfully launch a manned spaceflight. The United States and former Soviet Union achieved that feat four decades ago. ["China launches its 1st manned craft into Earth orbit," **Orlando Sentinel**, October 15, 2003, p A1 & A10.]

◆ The following is a statement from NASA Administrator Sean O'Keefe about China's first successful human space flight. "This launch is an important achievement in the history of human exploration. China, after Russia and the United States, is only the third nation to successfully launch humans into space. "The Chinese people have a long and distinguished history of exploration. NASA wishes China a continued safe human space flight program." ["NASA Administrator Marks China's Space Milestone," **NASA News Release #03-333**, October 14, 2003.]

◆ NASA has moved the Columbia Recovery Office (CRO) to Kennedy Space Center (KSC), Fla. By moving the CRO from Johnson Space Center, Houston, to KSC, NASA has the storage and coordination of Shuttle debris at one location. Although the volume of calls to report new debris has decreased, with hunting season about to begin in East Texas, where the majority of debris was found, there could be an associated increase in calls. The CRO opened April 28, 2003, and will remain operational as long as call volume warrants. "We are still interested in retrieving any debris reported by the public," said Dave Whittle, chairman of the NASA Mishap Investigation Team and head of the CRO. "From the standpoint of those calling in, the change should be invisible. Since KSC is the storage location for the debris, and since it is still the center receiving calls about Challenger, we feel they are the right people to handle long-term support of Columbia calls," he said. The toll-free Columbia Shuttle Material hotline is answered 24 hours a day, 7 days a week. Anyone who finds material believed to be part of Columbia is urged to call the hotline at: 1/866/446-6603. The CRO operates the Shuttle Interagency Debris Database for data management, record retention, and mapping. The CRO will arrange for larger or potentially hazardous Shuttle debris recovery. The CRO may ask finders to ship smaller, non-hazardous objects to the office. ["NASA Moves Space Shuttle Columbia Recovery Office," **NASA News Release #03-332**, October 14, 2003.]

◆ The grounding of the space shuttle fleet in the wake of the Columbia accident has led to "one of the most challenging periods in the history of the international space station program," the General Accounting Office reported Tuesday. Since Columbia broke apart as it re-entered the Earth's atmosphere Feb. 1, the space station has essentially been in survival mode. With the shuttles down, NASA and its 15 international partners agreed to shrink the crew from three to two, and the orbiting outpost depends on two Russian spacecraft, the unmanned Progress supply ships and the Soyuz, which carries astronauts to and from space. But the unavailability of the shuttles raises a number of other issues, according to the GAO report, which was requested by the Senate Commerce Committee. The GAO is essentially the investigative arm of Congress. Members of Congress have repeatedly pressed NASA officials for details about the effect of the accident on the space station. The agency's response has been that the station partners are working well together to keep the program afloat. Without the shuttles, construction of the station has stopped, because no other vehicle can carry the heavy components into orbit. Because of the grounding, "it is clear that the station will cost more, take longer to complete, and have further delay in the achievement of key research objectives," the GAO report says. In NASA's response to the report, Deputy Administrator Fred Gregory said the agency and its partners have worked aggressively to minimize the impact of the shuttle fleet's grounding. ["Space station work slows as cost rise," **Orlando Sentinel**, October 15, 2003, p A13.]

October 15: NASA could remotely ditch a damaged shuttle in the Pacific Ocean and rescue astronauts stranded at the International Space Station if a scenario like the one which doomed Columbia cropped up in the future. That was the word Wednesday from NASA astronaut who detailed for reporters an updated agency plan to return its grounded shuttle fleet to service next fall. "There is a method for undocking and de-orbiting safely into the southern Pacific Ocean area – away from any land masses and any population – a stranded and abandoned orbiter," said James Halsell, a key player in the agency's post-Columbia recovery effort. In the wake of the Feb. 1 Columbia accident, NASA engineers initiated a study aimed at determining whether astronauts on a crippled shuttle could use the station as a safe haven until a second ship could be launched on a rescue mission. The study determined the agency could put in place the food, supplies and equipment necessary to sustain as many as seven stranded shuttle astronauts and a two-person station crew for at least 86 days. Halsell said the engineers determined that minor shuttle computer software changes would be required. The idea then would be to guide the damaged shuttle by remote control to a safe splashdown in a remote area of the south Pacific. A veteran shuttle pilot and commander, Halsell called the scenario "an extremely unlikely event." But NASA nevertheless decided to take time to go through "a mental and planning exercise" just in case. With the exception of a planned Hubble Space Telescope servicing mission, all future NASA shuttle flights will be launched to the space station. ["Damaged shuttle to dock at station under new plan," **Florida Today**, October 16, 2003, p 2A.]

October 16: The future of human space flight looks bleak unless national leaders come up with creative ways to finance the next generation of space vehicles, lawmakers were told Thursday. The loss of the \$2 billion shuttle Columbia on Feb. 1 had been expected to ignite renewed interest in sending humans to Mars or beyond. But that hasn't happened. "There is a growing chorus of leaders inside and outside of

government concerned that NASA's post-Columbia investigation posture is business as usual," warned Wesley Huntress, Jr., a former NASA associate administrator for space science. Huntress and four other space science experts told the House Science Committee on Thursday that, for now, the United States is stuck with its aging, troubled and expensive space shuttle fleet and the incomplete International Space Station. With the National Aeronautics and Space Administration's approximately \$15 billion annual budget expected to remain relatively flat for the foreseeable future, there are few pleasant options. Alex Roland, a former NASA historian and now chairman of Duke University's history department, said the country should retire the shuttles and mothball the space station immediately. "For the short term, we do not need the shuttle and we do not need people in space," Roland told Science Committee members. The money saved could be diverted to developing a truly revolutionary launch vehicle that would conquer, once and for all and at a reasonable cost, the dangers of getting humans and cargo into orbit. From there, Mars and the rest of the inner solar system would be just a step away, Roland said. Rep. Sherwood Boehlert, R-N.Y., chairman of the Science Committee, said Congress, the White House and NASA have an obligation to reach a consensus on the future of human space flight. "The consensus has to include an agreement to pay for whatever vision is outlined," Boehlert said. "The federal government has too few resources and too many obligations to give NASA a blank check." At least three of the scientists who testified Thursday said the United States could mount a mission to Mars without the massive national program that was the hallmark of the successful Apollo program. Michael Griffin, NASA's associate administrator for exploration, predicted it would take the agency a decade to work out of its current dilemmas with the shuttle fleet and the space station. He said an extra \$5 billion per year could conceivably lead to a U.S. lunar base within 10 years as well as a Mars mission. Griffin did not estimate how long a successful Mars mission would take. Republican and Democratic committee members said Congress is not likely to fund any ambitious new programs. Web posted. (2003). [Columbia failed to spur leadership [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 16].]

October 18: The next crew of the International Space Station is on its way to the orbiting lab. For the second time since the shuttle Columbia disaster, a Russian Soyuz rocket roared off its Kazakhstan launch pad carrying not just a crew but the very survival of the 16-nation project. The in-bound station commander, NASA's Michael Foale, and his crewmate, Alexander Kaleri of Russia, embarked at 1:38 a.m. on what is expected to be a six-month stay. They will become the station's eighth resident crew. Riding along in the Soyuz is Spain's Pedro Duque, who will return to Earth on Oct. 27 with the departing station crew of American Ed Lu and Russian Yuri Malenchenko. ["Soyuz crew on way to station," **Florida Today**, October 19, 2003, p 1A & 2A.]

October 20: Kennedy Space Center and the U.S. Air Force Eastern Range will nearly double tracking camera coverage of future shuttle launch operations in the wake of the Columbia accident. The Columbia Accident Investigation Board found that existing camera capabilities were inadequate to support detailed engineering assessments of the external tank debris damage to Columbia's left wing. During the launch of Columbia, NASA and USAF had a total of 26 tracking assets monitoring the vehicle – 14 film and 12 video systems. For future launches what will be increased to 43 tracking systems, including 23 film and 20 HDTV systems. Long-range trackers will be doubled to 10 video and 10 film systems, while medium-range trackers will be increased by four each to seven video and seven film systems. Short-range trackers will also be increased somewhat, to six film cameras and three short-range HDTV systems. In addition to the tracking systems that move to follow the climbing vehicle, there are at least 42 existing "fixed cameras" aimed at individual sections of the shuttle that will also receive some upgrades. They are mounted around the Pad 39A and B perimeters, on the launch umbilical towers and on the mobile launcher platforms. ["The full picture," **Aviation Week & Space Technology**, October 20, 2003, p 17.]

October 23: NASA dispatched a new crew to the International Space Station after taking into account warnings by experts about unreliable medical equipment and air and water monitoring devices aboard the orbiting lab, an agency spokesman says. The spokesman, Robert Mirelson, said there was a full discussion by mid- and management-level engineers and it was their conclusion that despite the experts' concerns, the launch would be "well within the parameters of safety." Mirelson said Wednesday night there were a series of pre-launch meetings in Moscow, Washington and the Johnson Space Center involving NASA engineers and experts from the International Space Station partner nations. The officials considered the concerns expressed by engineers about the air cleaning equipment, water supplies and the "quality of life

equipment," which would include medical supplies, and concluded the launch would be safe. *The Washington Post* reported today, however, that two officials overseeing health and environmental conditions on the space station didn't sign off on the launch, instead signing a dissent that warned about "the continued degradation" of the environmental monitoring and health maintenance systems and exercise equipment vital to the astronauts' well being. The Russian spacecraft filled in for the second time since the U.S. shuttle program was grounded this year after the Columbia disaster, delivering a three-man crew Monday to the International Space Station. American Michael Foale, Russia's Alexander Kaleri and Spain's Pedro Duque entered the space station after the autopilot docking of their spacecraft, two days after the Soyuz blasted off from Kazakhstan. Duque is to remain aboard the station for eight days before returning to Earth with American Ed Lu and Russian Yuri Malenchenko, who have been aboard since April 28. NASA Administrator Sean O'Keefe told the *Post* that, as he understood it, there was no immediate hazard to the crew but that conditions could deteriorate in the next six months and force the crew to abandon ship. Web posted. (2003). [NASA launched space station mission despite experts' warnings, documents show [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 23].]

October 24: Kennedy Space Center Contractor Awards for Fiscal Year 2003 were announced during the Business Opportunities Expo 2003, Oct. 21, at Port Canaveral, Fla. KSC Director James Kennedy spoke during the event's opening ceremonies. "I am gratified to hear of awards for several small-business contractors who provide goods and services to KSC. We have a big job ahead of us and a need for the diversity the small business community will bring to the task," Kennedy said. Kennedy, along with Ralph Thomas, assistant administrator for the Office of Small and Disadvantaged Business Utilization at NASA headquarters in Washington, D.C., presented the awards to five contractor companies during KSC's bi-annual awards ceremony Oct. 22. OAO Corporation received the KSC Large Business Prime Contractor of the Year award for its outstanding socioeconomic performance on the Outsourcing Desktop Initiative for NASA's contract at KSC. Analex Corporation, Alexandria, Va., was presented with the KSC Small Business Prime Contractor of the Year award for providing exceptional services to the Expendable Launch Vehicle Integrated Support contract at KSC. The NASA-KSC Small Disadvantaged Business Subcontractor of the Year award was given to All Points Logistics, Inc., Titusville, Fla. All Points Logistics provided outstanding management services for the Checkout, Assembly and Payload Processing Services (CAPPS) Documentation Center at KSC. Spherion, Melbourne, Fla., received the NASA/KSC Woman Owned Small Business Subcontractor of the Year award. Spherion provided exceptional contract labor and staffing services on the Payload Ground Operations contract and the CAPPS contract at KSC. The KSC Small Business Subcontractor of the Year award went to East Coast Power, Inc., Titusville, Fla., for performing outstanding electrical services under the Joint Base Operations Support contract at KSC. "Small business is a major driving force in our economy," said Jim Kennedy. "We at the KSC will help ensure this invaluable resource survives and prospers." ["KSC Contractor Awards Announced at Business Expo 2003," **NASA News Release #86-03**, October 24, 2003.]

◆ NASA kept watch Friday as giant sun spots spewed massive amounts of high-energy particles toward Earth, but the angle of the sun in relation to the International Space Station meant there was no danger of increased radiation for five astronauts aboard. A similar storm three years ago forced the station's first crew to hide out for 12 hours in the Russian segment of the space lab, which is equipped with tougher radiation shielding. Friday afternoon, NASA spokesman James Hartsfield said there was no reason to take special action. "No impact," he said. "They're keeping a close watch over that, but this particular event did not have any additional radiation impact." Once the federal government's Space Environment Center in Boulder, Colo., predicted Friday's storm, procedure required them to alert radiation experts at Johnson Space Center. A special team at NASA's Texas center stayed in close contact with the space weather forecasters, monitoring the situation for possible dangers to the crew. The solar activity is forecast to be higher than normal during the next couple of weeks, and the teams will remain on heightened alert. The increased solar activity comes at a time when monitors aboard station that measure radiation levels -- along with other air and water monitors -- are not working. They have not been fixed because of the grounding of the shuttle fleet imposed by the Feb. 1 Columbia disaster. ["Flares won't endanger station crew, NASA says," **Florida Today**, October 25, 2003, p 2A.]

◆ Memories of Columbia's crew permeated a ceremony on the International Space Station on Friday, when the departing astronauts symbolically handed the orbiting outpost over to the new boys on the block.

Yuri Malenchenko and Ed Lu don't leave until Monday, when they and short-time visitor Pedro Duque head back to Earth, but they offered the station to new Commander Mike Foale and Alexander Kaleri. Malenchenko noted that his crew took over in the wake of the Feb. 1 Columbia disaster that killed seven astronauts. "It is a horrible tragedy first and foremost because of the loss of our friends," commander Malenchenko said in Russian. "Further, we lost the capability of shuttle flights to the station, and our resources were limited. We had to reduce the crew from three to two crew members. However, we continued our work, and we believe our friends have given their lives so we would continue space exploration." He said he was proud to work with the international team that is keeping the station flying. Foale, a British-born American, took the microphone, saying his crew was ready to accept responsibility for flying Alpha. "You've handed us a space station that's in excellent condition," he told Malenchenko. "You've carried out your mission very well." He pledged to pass the ISS on to the next crew in as good condition as he received it. "We will make sure that the loss of the lives most recently of our friends on the Columbia will not be in vain," Foale said. Foale formally accepted command with a handshake, and then the crews wrapped up the ceremony with more handshakes and hugs. ["Crew transfer honors Columbia," **Florida Today**, October 25, 2003, p 2A.]

October 25: Workers at Kennedy Space Center are replacing several cracked tread shoes on the crawlers that carry shuttles to the launch pads. The cracks will delay a rollout test scheduled for Monday, to the first week in December at the earliest, officials said Friday. The tread cracks were discovered this week on the first crawler as workers prepared for the test. Inspections of the second crawler should be finished by early next week, spokesman Bruce Buckingham said. About 9 percent of the 456 shoes on each crawler have cracks. KSC's Malfunction Analysis Lab will analyze a shoe to try to determine why they are cracking, he said. "We estimate we have enough spares for the job," Buckingham said, though the spares are being inspected, too. A new muffler system was recently installed on the crawlers. In the summer of 2002, workers replaced several doughnut-shaped, 40-pound bearings in hydraulic cylinders in the crawlers after cracks were found during a planned refurbishment. The 5.5-million-pound crawlers have been running for almost 40 years. They were used during the Apollo era to transport moon rockets to the launch pads. Each crawler transporter is a square, flat vehicle 131 feet long and 113 feet wide that carries a mobile launch platform and a shuttle from the Vehicle Assembly Building to the launch pad. Web posted. (2003). [Shuttle transporter crawlers get fitted with new treads [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 25].]

◆ One of the world's most famous lost watches, the one worn by astronaut Edwin "Buzz" Aldrin when he walked on the moon in 1969, has apparently resurfaced - in court. The Omega Speedmaster Professional Chronograph was lost 30 years ago when Mr. Aldrin agreed to give it to the Smithsonian Institution for public display. His shipment of astronaut memorabilia arrived at the Smithsonian but without the watch and several medals. NASA investigated the matter but did not find the watch. Since then Mr. Aldrin, space historians and collectors have wondered what happened to it. Now Stephen Morely, a retired businessman in Long Beach, California, says he has it and, in fact, has had it for a decade. To answer the questions surrounding its authenticity and ownership, Mr. Morely filed a suit in US District Court in San Diego. It brings together Mr. Morely, the Smithsonian, NASA and Mr. Aldrin, who retired from the astronaut corps in 1971. Early indications are that it is the watch that went to the moon. But who has the right to it is a sticky issue. A NASA memo insists that "if the watch is the one worn by Buzz Aldrin during his moon walk, the watch is the property of the government" and belongs at the Smithsonian. Mr. Aldrin is not talking about the case directly, but his lawyer says he would like the watch back. Mr. Morely says the watch is his, but he recognizes its historic importance, as well as its worth, and is willing to negotiate. If it ends up on the auction block through a judge's decision, he would split the proceeds. Everyone agrees Mr. Aldrin was wearing an Omega Speedmaster when he stepped on the moon on July 20, 1969. Curious about the watch's history after a collector offered to buy it, Mr. Morely checked the company's archives and discovered it was the same model as the one issued for the July 1969 moon flight. He says he contacted NASA and was told Mr. Aldrin's was lost. He researched further and says he found that NASA issued an Omega with the serial number 043 to Mr. Aldrin and he wore it on the Apollo 11 moon mission. His, he says, has the 043 number. The lawyer representing Mr. Aldrin, Robert O'Brien, says that is true. He stressed that no one was blaming Mr. Morely for the original disappearance. ["NASA fights man for watch," **Florida Today**, October 26, 2003, p 1C.]

October 27: NASA should shut down its year-old project to build a new spacecraft to ferry astronauts to and from the International Space Station, two key congressmen said in a letter released Monday. Concerned that the space agency is repeating mistakes of the past, Rep. Sherry Boehlert, R-N.Y., and Rep. Ralph Hall, D-Texas, urged the agency to end -- for now -- the orbital space plane program. "The OSP program will not be successful on its current track," the two congressmen wrote in a letter to NASA Administrator Sean O'Keefe. Boehlert is chairman of the House Science Committee and Hall is the senior Democrat on the panel. The letter is a significant development because it shows Republicans and Democrats are willing to challenge the Bush administration to come up with a new direction for the troubled civilian space agency. Before the Feb. 1 shuttle Columbia disaster, NASA had proposed building a smaller, more agile craft tentatively called an orbital space plane. Long-range cost estimates put the vehicle's price tag at \$13 billion. Several of the spaceships would be needed. Since the tragedy, NASA has proposed speeding up work on the space plane so that it could take over some of the duties now performed by the aging shuttle fleet. However, NASA has a history of underestimating costs and making unrealistic performance promises. Lawmakers hope to break that cycle by forcing a debate on what the nation should be doing in space, then directing NASA to design a vehicle to accomplish those goals. "We are not prepared to let budgetary gamesmanship damage another NASA program," Boehlert and Hall wrote. NASA officials received the letter Friday and are working on a response, spokesman Michael Braukus said. "We acknowledge the committee's concerns about the development of the orbital space plane," Braukus said. "We plan to work with Congress to alleviate them." The orbital space plane, still a concept on paper, would do nothing to address the weaknesses of the fragile shuttle fleet, the lawmakers wrote. It would not replace the shuttles, it would not dramatically reduce launch costs, and it is too soon to know if the craft would increase crew safety, they wrote. The letter comes as both the House and Senate prepare to hold another series of oversight hearings to learn more about how the space agency plans to recover from the Feb. 1 Columbia disaster. NASA officials could not provide an immediate reaction to the lawmakers' letter Monday. Web posted. (2003). [Lawmakers want to ground space plane project [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 27].]

◆ The newest part of the Space Mirror Memorial -- with the seven names of the Shuttle Columbia's fallen astronauts engraved on it -- will be unveiled this morning during a private ceremony. In July, workers installed the two new panels bearing the astronauts' names into the Space Mirror Memorial, a 42-foot-high and 50-foot-wide wall located near the entrance to the Kennedy Space Center Visitor Complex. Dan LeBlanc, chief operating officer for Delaware North Parks Services of Spaceport, the company that manages the Kennedy Space Center Visitor for NASA, said the space mirror offers people a chance to connect with tragic events in the space industry. "After the Columbia tragedy we had thousands of visitors come to pay their respects," LeBlanc said. "But this isn't attendance-driven, it's a place for people to think about these heroes." A black veil has shrouded the 500-pound panels since July. Today the seven new names will join those of 17 others astronauts on the wall. Family members from all seven of Columbia's crew will be present. "This is to ensure that these astronauts will never be forgotten," Feldman said. The Astronauts Memorial Foundation is a nonprofit group that was formed after the crew of the Challenger shuttle died shortly after lift-off in 1986. The memorial is to honor all U.S. astronauts who lost their lives on missions or while training for missions. The Space Mirror Memorial, dedicated in 1991 by former Vice President Dan Quayle, was designated a national memorial by Congress and former President George H. W. Bush. Web posted. (2003). [KSC adds names to Mirror Memorial [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 27].]

◆ NASA-Kennedy Space Center's Technology Transfer Office recently granted patent licenses on four of NASA's technologies, developed at KSC, for application in several commercial/industrial markets. Two of the license agreements are coupled with Space Act Agreements that allow the licensees to enhance the technologies for use in their commercial markets and for use by NASA. This "spin-in" mechanism is one way KSC partners with industry to leverage NASA's technology assets. NASA signed a patent license with Toxicological and Environmental Associates, Inc., Baton Rouge, La., for the use and sale of Emulsified Zero-Valent Iron (EZVI). NASA developed the innovative solution with the University of Central Florida, Department of Energy, Department of Defense, Environmental Protection Agency, and GeoSyntec, Inc. The new technology directly treats contaminant sources in ground water, reduces treatment time and costs, and produces less toxic and more easily degradable by-products. Toxicological and Environmental Associate's first deployment of the solution will be at Port Canaveral, Fla. Pacific Instruments, Inc.,

Concord, Calif., obtained a patent license for the commercialization of the Signal Conditioning Amplifier Recorder (SCAmPR). SCAmPR provides signal conditioning, amplifying and recording capabilities in a single circuit board, and can significantly improve reliability, reduce cost and provide more flexibility than pre-existing Ground Measurement Systems (GMS) used during Space Shuttle launches. SCAmPR exceeds the performance requirements established by the Space Shuttle GMS. A Space Act Agreement for co-development of SCAmPR and KSC's use of a Pacific Instruments developed Windows-based, client-server software for SCAmPR will support the agreement. TABER Industries of North Tonawanda, N.Y., received a patent license for the development and commercialization of the Multi-Sensor Array pressure transducer. This technology is composed of an algorithm to determine the health of a transducer. It lends itself directly to application on a microprocessor with the sensor cluster composed of Micro Electro-Mechanical Systems (MEMS) elements fabricated together on a single chip. The Multi-Sensor Array works with sensor units placed around Space Shuttle launch pads to record physical phenomena. The technology enables the sensor clusters to uniquely monitor their own health and estimate their own remaining lifetime. Supporting the agreement is a Space Act Agreement for joint development between NASA-KSC and TABER Industries that will result in a new innovative transducer design. The technology will be part of ground support instrumentation systems in government and commercial aerospace programs, reducing operating and maintenance costs while increasing instrumentation reliability. The Technology Transfer Office successfully completed the negotiation and signing of a patent license with Armor Holdings Forensics, Jacksonville, Fla., for the manufacture and sale of the KSC-developed scaling device and accompanying software. Engineers at KSC developed the scaling device to help technicians assess the damage to the Space Shuttle external tank following a hailstorm several years ago. The device uses a laser that projects a known pattern into a camera's field of view. When a photograph is taken, this pattern appears with the image of the object under investigation, allowing the viewer to quantify the size of the object. Accompanying software calibrates the pattern in the photo image and computes the distance scale for the entire image, saving valuable time in establishing and documenting measurements. Armor Holdings Forensics intends to use the technology in the law enforcement field. Jim Seidel, general manager of Forensics at Armor Holdings said, "We believe crime scene investigators and traffic accident investigators will find this device particularly useful in their work." The device has potential utility wherever remote scaling of a photographic image is required. ["NASA-KSC Grants Four New Technology Patent Licenses," **KSC News Release #88-03**, October 27, 2003.]

◆ Three astronauts landed safely on the steppes of Kazakhstan on Monday, Russian mission controllers said, completing the second International Space Station crew exchange accomplished entirely by Soyuz capsules. Unlike the last station crew, Commander Yuri Malenchenko and Ed Lu, along with European Space Agency astronaut Pedro Duque, didn't have to experience the high gravity forces of a ballistic landing. Instead, Malenchenko and Lu, who have been on the station for six months, and Duque, who flew up about a week ago with the new crew, landed at the expected landing site. "Soyuz, Houston, for Ed -- one last word, Aloha!" spacecraft communicator Mike Jensen said from the ground before the Soyuz pushed away from the station, telling the men what a pleasure it was to work with them. Lu, who considers Honolulu his hometown and has a fondness for Hawaiian shirts, echoed his sentiments. "See you on the ground," he said. Lu wore a Hawaiian shirt as he and Expedition 7 Commander Malenchenko formally handed the station over to new Commander Michael Foale and Alexander Kaleri on Monday. ["Station crew returns safely," **Florida Today**, October 28, 2003, p 1A & 2A.]

October 28: The crew of space shuttle Columbia might have survived if the cabin had been designed differently, according to documents released Tuesday by the independent panel that investigated the accident. The Columbia broke apart as it tried to re-enter Earth's atmosphere Feb. 1. The crew cabin, an enclosed pod that sits in the shuttle's nose, remained intact for a time. But when it fell apart, the seven crewmembers died from lack of oxygen and the force of the air that hit them. The crew cabin wasn't designed to withstand such a force, and it was initially assumed nothing could have been done to help the crew survive the breakup of the space shuttle. But James Bagian, a former astronaut who studied crew survival for the Columbia Accident Investigation Board, said Tuesday that the cabin could have remained intact if it had been more heat-resistant. The pod is made of aluminum, which loses strength when exposed to heat. If the cabin had remained intact and had been designed not to spin as it fell, the astronauts might have been able to parachute to safety, the investigators found. NASA installed parachutes and other escape equipment for use on the shuttle after the 1986 Challenger accident. A NASA spokesman said Tuesday that

the agency had just received the documents and was reviewing them. The findings could influence the design of a new NASA spacecraft. The agency hopes that a vehicle called the orbital space plane will carry crews to and from the International Space Station in a decade. Bagian said he has been asked to present his findings to engineers working on the space plane. NASA formed the accident board to investigate the cause of the tragedy. On Aug. 26, the board released a report criticizing NASA for lax safety practices and a rigid bureaucracy. NASA officials have vowed to act on all the board's recommendations. Web posted. (2003). [Panel: Different design might have enabled Columbia crew to survive [Online]. Available WWW: <http://www.usatoday.com/> [2003, October 28].]

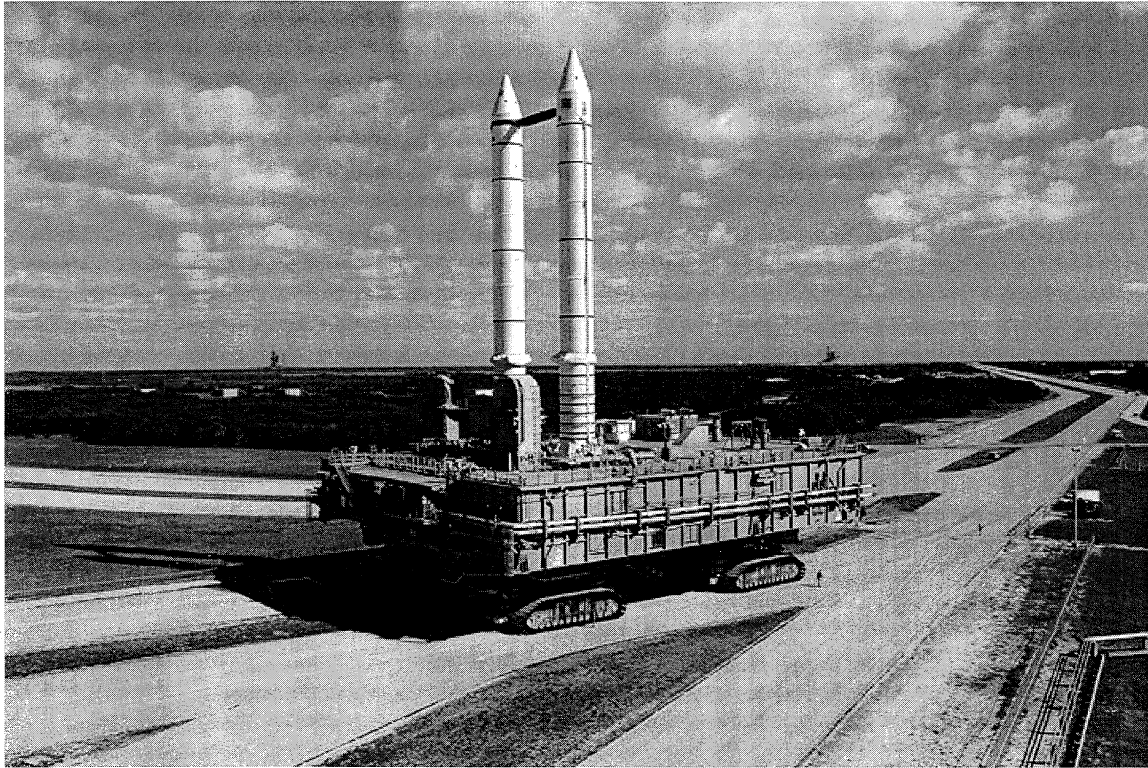
◆ The National Space Mirror Memorial reflected more than grief Tuesday morning as the names of the Columbia astronauts were unveiled. It reflected a flapping flag, NASA jets, and hopes for the future as astronauts, officials and family members alike talked about moving forward and exploring the universe. The greatest tribute to the seven astronauts killed Feb. 1 would be carrying on space exploration, said John Young, who commanded the first Columbia flight. "From those launch pads right over there, the future is waiting for us," he said at Kennedy Space Center Visitor Complex. The names of Rick Husband, Willie McCool, Mike Anderson, Laurel Clark, Ilan Ramon, Kalpana "K.C." Chawla and Dave Brown now are lit on the black wall of polished granite at Kennedy Space Center Visitor Complex. They join the Apollo 1 astronauts, the Challenger crew and astronauts killed in airplane accidents. "We truly are all Columbia families, because we've all shared the loss of the crew and the precious . . . spacecraft to carry the name Columbia, the shuttle, a marvelous vehicle in its own way," Jon Clark, Laurel Salton Clark's husband, told the crowd of dignitaries, family and friends. They included his 9-year-old son, Iain, who often leaned against his father as the ceremony wore on. Willie McCool's wife, Lani, and sons, parents and sister were there. So were Rona Ramon, widow of Israeli astronaut Ilan Ramon; Laurel Clark's mother, stepfather and siblings; Evelyn Husband, widow of shuttle commander Rick Husband; Sandy Anderson, Mike Anderson's widow; Doug Brown, brother of Dave Brown, and Dave's friend Ann Micklos; and Jean-Pierre Harrison, husband of Kalpana Chawla. The memorial is a testimonial to the future, Clark said. Web posted. (2003). [Tribute looks to future [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 28].]

October 30: NASA will press ahead with its plan to develop an orbital space plane despite congressional misgivings, space agency chief Sean O'Keefe said Wednesday. Two key congressmen asked NASA to postpone work on the \$13 billion project. "The concerns expressed by House members are legitimate," O'Keefe told senators during a hearing focused on NASA's future. But, he added, "We can work our way through this." On Monday, Rep. Sherwood Boehlert, R-N.Y., and Rep. Ralph Hall, D-Texas, released a letter sent to O'Keefe questioning the orbital space plane's viability. "The OSP program will not be successful on its current track," the lawmakers wrote. They requested NASA wait until after the White House, Congress and the American public agree on a goal for exploring space in the wake of the shuttle Columbia disaster. "Without such consensus on a shared vision . . . public support for the nation's civilian space program will inevitably founder," the letter warned. Sen. Sam Brownback, R-Kan., fretted NASA has spent \$5 billion on five different experimental space planes in the past decade with nothing to show for it. He said he feared the orbital space plane would become the sixth failure. In an appearance Wednesday before a Senate Committee, O'Keefe said NASA is at least 12 months from awarding a contract on the first phase of the orbital space plane. With that timetable, House members should not have to worry about the agency "getting out in front of the headlights," O'Keefe said. O'Keefe sent a formal response to Boehlert and Hall Wednesday, but the document did not satisfy the two congressmen. . Web posted. (2003). [Space plane plans move forward [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 30].]

◆ Eight months after the shuttle Columbia tragedy, some NASA employees have yet to accept that the federal agency must change, space agency administrator Sean O'Keefe said Thursday. "We've got to recognize it, and we've got to get out of the denial phase," O'Keefe told employees in an afternoon appearance broadcast live to the entire NASA work force. Standing on an auditorium stage at NASA headquarters, O'Keefe said the agency is making progress toward implementing safety recommendations made by the Columbia Accident Investigation Board. He repeatedly returned to the theme that NASA's work force -- from experienced managers to newly hired technicians -- needs to embrace a new ethos of openness and communication to avoid the false sense of security that contributed to the loss of seven astronauts and a \$2 billion shuttle Feb. 1. In an attempt to boost morale and show workers the agency has overcome extreme challenges in the past, O'Keefe turned over the stage to Gene Kranz, the straight-talking,

nerves-of-steel flight director immortalized in the movie "Apollo 13." Now a motivational speaker, Kranz said he is confident NASA will recover. "We've seen the triumphs of high achievement," Kranz said. "When we failed, at least we failed while daring greatly. This, I believe, is the legacy of this agency." Kranz recalled the commitment and teamwork that was NASA's hallmark in its early years. He also recounted the grief that engulfed the young agency when the Apollo 1 crew was killed in a launch-pad fire on Jan. 27, 1967. "At 6:31 that evening, we were startled by screams coming from our crew," Kranz said, his voice betraying little emotion. "We listened to their screams as they died. We knew we were responsible for America's first space disaster." For NASA workers now coping with the aftermath of the Columbia tragedy, Kranz offered words of encouragement but no easy solutions. "The American public has a very short memory," Kranz said. "It is very important for NASA to continue to put into public focus what we are doing, why we are doing it. You've got a real challenge." As part of his push to help NASA's work force embrace the findings of the Columbia Accident Investigation Board, O'Keefe said he is designating the week of Nov. 17 as a special time of awareness for individuals and teams all over the agency to read the board's report and discuss its findings. Web posted. (2003). [O'Keefe: Denial must end [Online]. Available WWW: <http://www.floridatoday.com/> [2003, October 30].]

During October: Complex electrical and software tests continue on the International Space Station's Japanese/Mitsubishi Kibo module and Italian/Alenia Node-2 hardware at the Kennedy Space Center. The Node-2 module will be launched to the ISS first, and the much larger Kibo will dock to it later. The modules were recently jointed electrically and have been connected to shuttle orbiter and ISS software emulators to validate interactions between all the hardware. This Multi-Element Integrated Test involved U.S., Japanese, Italian and Canadian technicians as well as potential astronaut crewmembers from the U.S., Japan and Brazil. The test itself has been in preparations for three years. Only the U.S. Destiny lab already on the ISS exceeds the Kibo lab in its operational complexity. The Japanese shipped the equivalent of 45 tractor-trailer loads of equipment to Kennedy to support the ongoing Kibo testing. ["Module Tests Advance," Aviation Week & Space Technology, October 27, 2003, p 17.]



Mobile Launcher Platform (MLP) number 3 and a set of twin solid rocket boosters bolted to it, atop the crawler-transporter, crawl to the intersection in the crawlerway in support of the second engineering analysis vibration test on the crawler and MLP. In the background are Launch Pads 39A (right) and 39B (left). The crawler is moving at various speeds up to 1 mph in an effort to achieve vibration data gathering goals as it leaves the VAB, travels toward Launch Pad 39A and then returns.

NOVEMBER

November 5: Fire usually doesn't come to mind when thinking of preserving the ozone layer and preventing global warming. However, at NASA-Kennedy Space Center those objectives were ever-present in the development of a new fire suppression agent. NASA-KSC has filed a patent application for the dry powder substance that combines the best properties of water and Halon fire extinguishing agents. The agent is made of microencapsulated water, which means it's not evaporated into the atmosphere making it a more powerful suppressant that's also appropriate for the environment. "This is providing a replacement for Halons currently being used, but are banned from being manufactured because they are harmful to the environment. This is a new class of fire extinguishing agents that can compete effectively against other hand-held systems," said the technology's visionary, Dr. Clyde Parrish, NASA senior chemist at KSC. Companies have expressed interest in the development, which can be used indoors and outdoors, and could license the technology and manufacture the agent, while KSC would earn royalties. NASA then has the option to purchase the commercial product for use. Parrish explained its potential. "Locally, it can be used in firing rooms for electrical equipment and on board the Shuttle." While the suppressants, in place at numerous KSC locations, are dated, it takes time to research and resolve issues, and develop a better option. Knowing the need for a new agent, Parrish envisioned the concept, and decided to begin development. After two years, working primarily with three lab associates, he realized the goal of creating the non-toxic fire suppression agent. ["KSC Develops Earth-Friendly Fire Suppression Agent," **KSC News Release #90-03**, November 5, 2003.]

◆ NASA's Voyager 1 spacecraft is about to make history again. It is the first spacecraft to enter the solar system's final frontier, a vast expanse where wind from the sun blows hot against thin gas between the stars: interstellar space. However, before it reaches this region, Voyager 1 must pass through the termination shock, a violent zone that is the source of beams of high-energy particles. Voyager's journey through this turbulent zone will give scientists the first direct measurements of our solar system's unexplored final frontier, the heliosheath. Scientists are debating if this passage has already begun. Launched on September 5, 1977, Voyager explored the giant planets Jupiter and Saturn before being tossed out toward deep space by Saturn's gravity. It is approaching, and may have temporarily entered, the region beyond termination shock. At more than eight billion miles from the sun, Voyager 1 is the most distant object from Earth built by humanity. ["Voyager Approaching Solar System's Final Frontier," **NASA News Release #03-354**, November 5, 2003.]

◆ NASA has awarded a contract with a potential value of \$165.8 million for support of International Space Station (ISS) Cargo Mission services to Lockheed Martin Space Operations of Houston. The ISS Cargo Mission contract is among the contracts being awarded as part of a restructuring of ISS contracts seeking to consolidate work, increase efficiency, increase accountability, and transition the program's contract strategy from development and construction of hardware to orbital operations. Work under the contract will provide services related to the planning, preparation and conduct of cargo missions to the International Space Station. The contract activities will include: cargo mission planning, cargo coordination, stowage integration, analytical integration, physical processing, decals, placards, graphics, on-orbit operations, sustaining engineering, management, and the integration of commercial cargo carriers and services. Options under the contract are available to provide stowage integration services to the Space Shuttle Program, NASA prepacked-cargo processing for the Japanese H-II Transfer Vehicle and NASA prepacked-cargo processing for the European Automated Transfer Vehicle, which are planned to provide future logistics support to the ISS. The basic period of the cost-plus-award-fee contract is four years and nine months, with an estimated value of \$108.5 million. Two one-year extension options to the basic period are available and would bring the total contract value to \$165.8 million. Work on the contract will be performed at NASA's Johnson Space Center in Houston, NASA's Kennedy Space Center in Florida and its immediate surrounding areas, and other locations inside and outside the United States. Major subcontractors include United Space Alliance of Houston, Teledyne Brown Engineering of Huntsville, Ala., and Bastion Technologies of Houston. ["NASA Awards Space Station Cargo Mission Contract," **NASA News Release #c03-qq**, November 5, 2003.]

◆ NASA has awarded a contract with a potential value of \$145.1 million for support of International Space Station mission integration services to Barrios Technology, Inc. of Houston. The International Space Station Mission Integration Contract is among contracts being awarded as part of a restructuring of Station contracts seeking to consolidate work, increase efficiency, increase accountability, and transition the program's contract strategy from development and construction of hardware to orbital operations. Work under the contract will provide products and services that support mission planning, mission integration, mission operations, international partner integration, and Russian language and logistics services. The basic period of the cost-plus-award-fee contract is four years and nine months, with an estimated value of \$99.9 million. Two one-year extension options to the basic period are available and would bring the total contract value to \$145.1 million. ["NASA Awards Space Station Mission Integration Contract," **NASA News Release #c03-rr**, November 5, 2003.]

November 7: James Fesmire, NASA lead engineer of the Cryogenics Testbed Facility at Kennedy Space Center, received the *R&D 100* Award for his work on a new product, "Flexible Aerogel Superinsulation," a composite insulation blanket. *R&D* (formerly *Research & Development*) named Fesmire an innovator and the product "one of the most technologically significant of the year." Fesmire received the *R&D 100* Award during the 41st annual awards ceremony last month in Chicago, Ill., for his pioneering idea in thermal insulation. KSC Deputy Director Dr. Woodrow Whitlow attended the event as Aspen Aerogels, Inc. of Marlborough, Mass., and NASA-KSC jointly received the award. *R&D* recognizes the efforts of the best scientists and engineers in industry, government, and academic research laboratories. "It is truly an exceptional achievement for the Center, and for James' work to be chosen as one of the top innovations of the year. With so many outstanding individuals around the world making breakthroughs each year, most researchers never earn this recognition," said Whitlow. Fesmire, a KSC employee for over 20 years, started research in advanced insulation technology in 1992 when he first learned about monolithic solid aerogels--commonly referred to as "frozen smoke." His investigation into the technology led him to believe that a durable and flexible composite aerogel material could be designed while retaining the excellent thermal insulating properties similar to the solid type. ["NASA-KSC Engineer Receives R&D 100 Award For New Insulation Technology," **KSC News Release #91-03**, November 7, 2003.]

◆ A top-to-bottom review of the International Space Station has turned up a number of safety concerns that NASA officials said they are working to correct. Managers found five items that were determined to be unacceptable risks and are drawing up plans to fix them or conduct further tests. An on-board defibrillator device -- defibrillators deliver an electrical shock to restore a heart's normal rhythm -- has a wiring problem. The main box for distributing power from the solar arrays to the space station also is suspect because it has not been tested for its ability to withstand vibration. Managers also found problems with a heat-dissipating radiator on the outside of the station, an ammonia storage device, and wiring to a robotic work station. The crew is in no immediate danger, said Mike Suffredini, a top NASA space station official who briefed reporters Thursday. The space station review was a direct response to the Feb. 1 Columbia tragedy and the landmark Columbia Accident Investigation Board report. If a life-threatening event were to occur on the orbiting outpost, the U.S. astronaut and Russian cosmonaut now living on board could return to Earth using the Russian Soyuz space vehicle docked to the station. The five components deemed "unacceptable risks" were among 722 pieces of hardware, software and procedures given "waivers" while the space station was being planned and built. The Columbia Accident Investigation Board criticized the space agency for relying too heavily on such waivers and unintentionally increasing risks for those flying on the shuttles and living on the space station. ["Five station risks alarm NASA," **Florida Today**, November 7, 2003, p 1A & 2A.]

◆ The STS-114 crew, augmented by three new members, is in place for the Space Shuttle's Return to Flight mission. Three Mission Specialists have been added to the four astronauts already in training for the STS-114 mission planned for launch no earlier than September 2004. The new crewmembers, Andrew Thomas (Ph.D.), Wendy Lawrence (Capt., USN) and Charles Camarda (Ph.D.) join mission commander Eileen Collins (Col., USAF), Pilot James Kelly (Lt. Col., USAF), Mission Specialists Stephen Robinson (Ph.D) and Soichi Noguchi, of the Japan Aerospace Exploration Agency, who were named to this flight in 2001. "STS-114 is going to be a complex developmental test flight, and this crew has the right set of skills and experience to help get the Space Shuttles safely flying again," said NASA's Associate Administrator for Space Flight William Readdy. "STS-114 was always slated to have a crew of seven. But now, instead of

three crew rotating on-and-off the International Space Station, all crew members will be dedicated to the STS-114 mission objectives," Readdy said. The major mission objectives of the STS-114 flight have shifted from International Space Station logistics and crew rotation to testing and evaluating new procedures for flight safety. This includes Shuttle inspection and repair techniques. It also includes a smaller set of Space Station tasks from what was scheduled before the Shuttle Columbia accident in February. ["NASA Names Crew members For Shuttle Return To Flight Mission," **NASA News Release #03-360**, November 7, 2003.]

◆ Operation of Launch Complex 47 at Cape Canaveral Air Force Station was transferred from the U.S. Air Force's 45th Space Wing to the Florida Space Authority (FSA) on Thursday through a licensing agreement under the Commercial Space Transportation Act. As part of the agreement, Brevard Community College (BCC) of Melbourne, Fla., will be responsible for ground operations and the University of Central Florida's Florida Space Institute-- which has headquarters on Kennedy Space Center property -- will be responsible for flight operations. "We are thrilled to transfer use of this launch pad to FSA and its partners," said Brig. Gen. Greg Pavlovich, commander of the 45th Space Wing. "Through the efforts of all involved, we took an active launch pad that was scheduled to be deactivated and turned it over to the State of Florida to be used for educational opportunities for years to come." "We are pleased to partner on this educational venture that will assist in developing the next generation of aerospace professionals," added Winston Scott, FSA's executive director. Complex 47 is the Cape's home for the Super Loki, a two-stage rocket that stands about 15 feet tall and is launched on a rail. The first stage includes a solid-fueled rocket motor that provides all of the thrust for the mission. The second stage is an inert dart that carries the payload to the edge of space but doesn't enter orbit. Web posted. (2003). [Florida Space Authority will Run Cape Launch Pad for Education [Online]. Available WWW: <http://www.space.com/> [2003, November 7].]

November 10: A former Kennedy Space Center employee was sentenced Monday to a year of probation and a \$2,000 fine for stealing a 3-inch piece of debris while helping to recover parts of the shuttle Columbia in Texas. Michael Pankiewicz, 44, pleaded guilty to a misdemeanor count of theft of government property earlier this year as part of an agreement in which federal prosecutors agreed to drop three felony charges of stealing government property, transporting stolen goods across state lines and making false statements. The felony charges were dropped after experts were unable to prove that the value of the metallic shuttle piece, about twice the size of U.S. dollar coin, was more than \$1,000. ["Ex-NASA employee pleads guilty," **Florida Today**, November 11, 2003, p 1B.]

November 12: NASA's Assistant Administrator, Office of Space Flight, William Readdy, announced today David Throckmorton is Deputy Director, Stennis Space Center (SSC), Miss., effective December 1, 2003. Throckmorton was the NASA Marshall Space Flight Center (MSFC), Huntsville, Ala., engineering directorate deputy director. He led a large, multidisciplinary workforce engaged in engineering design, analyses, development, and test in support of the broad array of NASA space flight programs. ["NASA Names Stennis Space Center Deputy Director," **NASA News Release #03-361**, November 12, 2003.]

◆ NASA Administrator Sean O'Keefe announced today the appointment of U.S. Navy Rear Admiral Thomas Q. Donaldson, V as the Director, John C. Stennis Space Center (SSC), Miss., effective January 5, 2004. ["NASA Names New Stennis Space Center Director," **NASA News Release #03-362**, November 12, 2003.]

November 14: NASA Administrator Sean O'Keefe announced the team that will lead the new NASA Engineering and Safety Center (NESC). The NESC is an independent organization, chartered in the wake of the Space Shuttle Columbia accident, which will coordinate and conduct robust engineering testing and safety assessments to support critical NASA projects and programs. "I based the NASA Engineering and Safety Center at the agency's original field center, the Langley Research Center in Hampton, Virginia, and I tasked Langley's Director Roy Bridges to get it up and running," said Administrator O'Keefe. "Roy has assembled a dynamic group of recognized experts in the fields of engineering analysis and risk mitigation, and the NESC is open for business." Ralph Roe Jr. is the Director of the NESC. Roe is a former manager of the Space Shuttle vehicle engineering office at the NASA Johnson Space Center, Houston. The Deputy Director is Dr. Paul M. Munafo, former manager of materials, processes and manufacturing at the NASA Marshall Space Flight Center (MSFC), Huntsville, Ala. The Deputy Director for Safety is Larry Crawford,

former director of research engineering at the NASA Dryden Flight Research Center, Edwards, Calif. Operationally, the NESC falls under the responsibility of NASA's Office of Safety and Mission Assurance (OSMA.) "The NESC represents an important enhancement to the agency's safety and engineering oversight capabilities," said former astronaut and NASA's Associate Administrator for OSMA, Bryan O'Connor. As chartered, the NESC workforce will be supplemented through partnerships with other federal agencies, national laboratories, industry, the military and academia. Areas for independent assessment will be carefully selected and managed with a strong focus on customer needs. Work will be prioritized based on technical risk, the need for independence and the potential for value-added contribution. ["NASA Names Leaders For Engineering and Safety Center," **NASA News Release #03-352**, November 14, 2003.]

◆ A NASA manager criticized for his role in the Columbia disaster was tapped Friday to direct a new safety and engineering watchdog group that will oversee all space agency programs. Ralph Roe, a former shuttle program manager reassigned in the wake of the Feb. 1 accident, will head up the NASA Engineering and Safety Center at Langley Research Center in Hampton, Va. Roe's appointment drew immediate criticism from Congress, where at least one legislator intimated that his performance during the Columbia mission should disqualify him from serving in the new organization. But the 20-year NASA veteran said the disaster -- which resulted in the deaths of seven astronauts -- prepared him to take on his new post. "I think sometimes that as human beings, we often learn more from our failures than from our successes," Roe said Friday. "Going through the accident, all of us in the program were affected tremendously. We had our friends and our colleagues on board (Columbia). So it has marked us and scarred us differently, and in a very hard way," he said. "We all will take those lessons and make sure we do our part to learn from happened during Columbia and try to do our best to improve the agency and make spaceflight safer." Roe -- who was serving as NASA's director of shuttle vehicle engineering at the time of the accident -- is one of four program managers who subsequently resigned or were reassigned. During the Columbia mission, he played a role in the quick dismissal of concerns about potential damage from external tank foam insulation that struck the shuttle's left wing 82 seconds after its Jan. 16 launch. Unknown to NASA managers at the time, the debris strike opened a hole in the wing, ultimately allowing hot gases to penetrate the ship and trigger its destruction during atmospheric re-entry. Roe also was one of several managers who concluded there was no need to obtain spy satellite photos of Columbia in orbit to better gauge the severity of damage to the shuttle. And the former Kennedy Space Center launch director also left Houston to attend a rocket booster test firing in Utah during the 16-day science flight, leaving deputies to attend key mission management team meetings. Roe's appointment was lambasted by U.S. Sen. Fritz Hollings, D-S.C., and a member of two key NASA oversight committees. "Here they go again," said Hollings, adding that the "decision to promote Mr. Roe, who was at the very center of the agency's controversial safety decisions, just reinforces my belief that NASA cannot reform itself." Langley Research Center Director Roy Bridges, however, said Roe is the right person to lead the new organization. Web posted. (2003). [NASA promotes criticized manager [Online]. Available WWW: <http://www.floridatoday.com/> [2003, November 14].]

◆ The first in a series of engineering data gathering tests will be performed next week involving the Space Shuttle's crawler transporter and the Mobile Launcher Platform (MLP) at Kennedy Space Center. Scheduled to begin Monday, Nov. 17, the crawler transporter will move the MLP, carrying a set of twin solid rocket boosters slowly out of the Vehicle Assembly Building (VAB) in support of engineering analysis vibration tests on the crawler and MLP. The crawler will be moving at various speeds up to 1 mph in an effort to achieve vibration data gathering goals as it leaves the VAB and then returns. The primary purpose of these rollout tests are to gather data that will be used to develop future maintenance requirements on the transport equipment and the flight hardware. Various parts of the MLP and crawler transporter have been instrumented with vibration data collection equipment. Additional rollout tests will be performed in the following months without the booster set for the purposes of gathering data in various hardware configurations. ["Mobile Launcher Platform Vibration Tests Scheduled for Next Week," **KSC News Release #95-03**, November 14, 2003.]

November 16: Institutional breakdowns that doomed Columbia and its astronauts are prompting NASA to take corrective action not only in its shuttle and space station programs, but also across the agency. Nine and a half months after the Feb. 1 accident, a NASA review team found stifled communications, schedule pressure, flawed decision-making and a fear of raising safety issues could lead to failures within other

agency programs. So NASA civil servants and contractors across the nation this week will read and discuss in meetings a stinging report issued Aug. 26 by the Columbia Accident Investigation Board. The idea is to prompt cultural change -- and avoid future disasters -- by opening up an agency-wide dialogue on the findings, recommendations and observations of the Columbia board. The board traced the accident to a foam debris strike to Columbia's left wing. But investigators placed equal blame on managerial mistakes and cultural flaws that shifted the agency's focus away from flight safety. "The focus of the meetings will be on how you might apply these lessons within your life, your work unit, (NASA) center, or program," Kennedy Space Center Director James Kennedy said in a letter distributed to workers here. "Ask yourselves, 'What will I/we do differently?' The resulting answers can have a profound impact on how we operate as an agency and the level of success we achieve." Unprecedented in scope, the discussions are central to what NASA is calling "Safety and Mission Success Week" at its headquarters and 10 field centers. About 77,935 black-and-white copies of the board's 248-page final report were sent to workers across the nation. The printing and distribution cost: \$259,764. NASA spokesman Doc Mirelson said the money was drawn from an agency account set aside to finance the investigation into, and recovery from, the Columbia accident. Also shared with employees: A draft report compiled by a high-level internal task force conducting a comprehensive review of the Columbia report. Its aim: To determine how board findings might apply to all NASA programs. The Columbia board listed 29 recommendations, 27 observations and 137 findings in its final report. ["All of NASA to review report," **Florida Today**, November 17, 2003, p 1B & 4B.]

November 17: After a review of test data, a decision has been made to reschedule the launch of Gravity Probe B (GP-B). The launch had been scheduled for Dec. 6 from Vandenberg Air Force Base in California. Data obtained during spacecraft prelaunch testing shows electronic noise on an output channel associated with the No. 1 experiment gyro. This could compromise the quality of data received from it. The problem has been isolated to a component in the spacecraft's experiment control unit (ECU). While there is a second available output channel for this gyro, a postponement of the launch will allow time for a repair. This precaution will restore full redundancy to the experiment and provide the greatest chance for success over the planned 16-month life of the mission. At Space Launch Complex 2, the rocket has successfully completed the scheduled prelaunch preparations up to this time, and there are no issues or concerns with the Delta II. The current plans are for it to remain at the pad enclosed within the gantry-like mobile service tower until the spacecraft arrives. The length of the postponement will not be known for about a week until a course of action has been developed to address the GP-B problem. ["Launch Advisory: Gravity Probe B Launch Postponed." **KSC News Release #96-03**, November 17, 2003.]

◆ NASA plans a rare rollout today of a massive shuttle crawler carrying only a platform with two solid rocket boosters. The test is designed to measure how much vibration the crawlers pass to flight hardware, such as the boosters. A 5.5 million-pound crawler will carry the specially instrumented mobile launch platform and boosters slowly away from the Vehicle Assembly Building at Kennedy Space Center. Then it will turn back and enter another bay in the VAB. The crawlers, which once carried moon rockets, are used to haul space shuttles to the launch pads. The test was delayed once, with a December target date, while workers replaced cracked tread shoes on the two crawlers. Repairs were finished on one crawler, so the test was moved up. The rollout, which begins at 7 a.m. -- weather permitting -- is the first of three planned for this week. Web posted. (2003). [NASA to test crawler to measure vibrations [Online]. Available WWW: <http://www.floridatoday.com/> [2003, November 17].]

November 18: They are the detectives of Kennedy Space Center. One lab may preserve what it tests. Another may destroy it. But the analysts have a common enemy: failure. Among their recent targets are the reinforced carbon-carbon panels from the leading edge of the shuttles' wings, whose failure led to Columbia's demise. "Remember the famous panel that they shot the hole in? Well, this is a piece of it," said Pete Engel, an engineering specialist with Wyle Laboratories, pointing to a sliver of RCC. Tests after the accident showed insulating foam shot at the panels at launch speeds could break a hole in them. Through nondestructive testing -- in this case, beaming a thin fan of radiation through the RCC using a process called computed tomography -- Engel is profiling the material. "What I'm finding is some anomalies in this coating that may or may not be serious," he said. The Nondestructive Evaluation Laboratory looks at everything from big crane hooks to little shuttle parts. The lab still is examining tread shoes on the giant crawler-transporters to document more cracks. One of the two crawlers exercised its new shoes Monday

morning by carrying a pair of solid rocket boosters out of the Vehicle Assembly Building and back, to measure how much vibration they experience. The nondestructive lab's goal is to prevent breakdowns by examining equipment before it fails. Its counterpart is the materials science laboratory, which will break something apart if necessary to figure out why it went bad. The materials science lab has looked at items from fractured railroad rails that interfered with rocket rollouts to cracked crawler shoes, said Scott Murray, acting chief of the lab. A prototyping lab within the materials lab may fabricate items needed for an investigation. One of its projects was the three-dimensional frame that held pieces of Columbia's left wing when the debris was assembled at KSC. The accident posed a special challenge for the labs. "That's pretty much an unprecedented type of a failure," Murray said. Though the investigation is over, the labs now are working on returning the shuttles to flight. For Engel and the nondestructive testing lab, that effort means verifying tests of Atlantis' wing panels. The panels already have been to two other sites for testing, he said. Web posted. (2003). [Labs home for sleuths [Online]. Available WWW: <http://www.floridatoday.com/> [2003, November 18].]

November 19: The Space Life Sciences (SLS) Laboratory was dedicated today in a ceremony hosted by NASA's Kennedy Space Center (KSC) and the state of Florida. The 100,000 square-foot facility houses labs for NASA's ongoing research efforts, microbiology/microbial ecology studies and analytical chemistry labs. Facilities for space flight-experiment and flight-hardware development, new plant growth chambers, and an Orbiter Environment Simulator that will be used to conduct ground control experiments in simulated flight conditions for space flight experiments also call the new lab home. Lt. Governor Toni Jennings said, "Today we celebrate the dedication of the new Space Life Sciences Lab and a new era in education and economic partnership. This new facility will greatly benefit Florida's university community." Jennings is chair of the Florida Space Authority's Board of Supervisors. Invited guests included dignitaries, government representatives and partners. "The SLS Lab provides NASA's gateway to space with operations and research capability to effectively use the International Space Station and take full advantage of research and commercialization opportunities," said KSC Director Jim Kennedy. "It provides a meeting place for our partners in research to work together. We anticipate researchers from around the world performing investigations in the SLS Lab, addressing key issues in biological sciences, enabling improved life on earth and long duration space flight," he said. The facility, completed in August of this year, represents a partnership between NASA and the state of Florida. The state, through Florida Space Authority, built the research laboratory. The facility is part of a \$30 million project that also includes Space Commerce Way, the new public roadway providing 24-hour access to International Space Research Park. ["NASA's Gateway To Space for Life Science Research Dedicated Today, **NASA News Release #03-373**, November 19, 2003.]

◆ NASA appointed nine replacements to a retooled Aerospace Safety Advisory Panel, every member of which resigned two months ago in the wake of the shuttle Columbia tragedy. The new panel, which includes one member of the board that investigated the shuttle accident, comes with a new charter the agency said would provide stronger oversight of safety issues in NASA programs. Steven Wallace, a member of the Columbia accident board and the head of accident investigations at the Federal Aviation Administration, is among the nine new members. Two other members, Ret. Navy Rear Adm. Walt Cantrell and Syracuse University public administration professor Rosemary O'Leary, already are serving on another committee that is overseeing NASA's progress toward returning the space shuttles safely to flight. NASA Administrator Sean O'Keefe said the panel's revamped charter was based on the original one signed when Congress created the oversight group following the tragic Apollo 1 fire that killed three astronauts in 1967. The new safety panel will hold its first meeting soon, but NASA could not provide a specific date. The agency also said the new safety group will report to the administrator quarterly instead of annually as the old panel did. "We've taken extra steps to ensure the independence of this panel," Associate Administrator for Safety and Mission Assurance Bryan O'Connor said in a statement. "While the original law and the new charter allow for NASA members, none of the new members is a current or former agency employee or contractor." The new document requires NASA to draw the panel members from safety, management and engineering experts in industry, government and universities. ["NASA replaces safety board," **Florida Today**, November 19, 2003, p 3A.]

◆ NASA intends to have a second shuttle poised to fly a rescue mission should its first post-Columbia astronaut crew get stranded at the International Space Station, agency officials said Tuesday. In an

emergency then, the second shuttle would have to launch within three months of the first. The deadline would be driven by the amount of time the outpost could serve as a safe haven for two station residents and seven shuttle astronauts. "Right now our safe haven capability on the International Space Station . . . is about 86 days," NASA shuttle program manager William Parsons said. "So what you would want is the ability to fly the second flight within about 86 days of the first flight." In the wake of the Feb. 1 Columbia accident, NASA put in place an emergency plan to sustain shuttle crews on the station should a systems failure or damage make an orbiter unfit for atmospheric reentry. The plan calls for increasing the amount of food, water and other supplies routinely stored aboard the station. It also is dependent on the ability to: Transfer 290 gallons of water from a disabled shuttle to the station. Continue on-schedule launches of Russian Progress cargo carriers with critical supplies during the time a shuttle crew is stranded on the station. Vital life support systems -- such as oxygen generation devices, condensation collectors and carbon dioxide scrubbers -- would have to be operating properly on the station. There also would be little or no ability to contend with any failure of other key station systems. Parsons said NASA has instructed its prime shuttle contractor -- United Space Alliance -- to have both Atlantis and Discovery flight-ready by next September, when the agency hopes to launch its first post-Columbia mission. Doing so serves another purpose, Parsons said. Either of the orbiters then could be launched on NASA's next flight should problems crop up with one of the ships. ["Agency plans call for emergency shuttle," **Florida Today**, November 19, 2003, p 3A.]

November 20: If disaster strikes aboard a space shuttle shortly after takeoff, astronauts will have people such as Petty Officer 3rd Class James Quinn waiting on the ground. Quinn is part of a Navy medical team from Rota that travels to Moron Air Base every time a shuttle launches from Florida. Astronauts have 35 minutes from the time the rocket boosters lift an orbiter off the pad to make an emergency landing at the Spanish air base. The 60-member team held an exercise Thursday in Rota to practice what it would do if a space shuttle had to abort a mission minutes after takeoff. During the drill, Quinn barked out commands to the other firefighters, who helped rescue sailors playing the part of injured astronauts. Using bulky, silver chemical suits and a C-12 propeller plane resembling a space shuttle, the team trained for disaster. Space shuttle Atlantis is scheduled for launch in September 2004. It will be the first journey into space since Columbia broke apart over Texas on Feb. 1, killing all seven astronauts on board. Moron Air Base, a small Air Force base 35 miles southeast of Seville, is one of three major emergency landing sites in Spain and Morocco. Web posted. (2003). [Moron drills for shuttle emergency landing [Online]. Available WWW: <http://www.estripes.com/> [2003, November 21].]

November 21; NASA Administrator Sean O'Keefe criticized Congress on Friday for apparently cutting \$200 million from the International Space Station budget. As Congress rushed to complete the last of the annual spending bills before leaving town for the remainder of the year, NASA's budget was among the federal agencies whose funding levels had yet to be determined. Although lawmakers had yet to file their final agreement, O'Keefe said it was his understanding \$200 million had been taken out of the space station budget and applied to some other project. "This will put a severe crimp in our reserves," O'Keefe said Friday during a roundtable discussion with reporters at NASA headquarters. Spokespersons for the House and Senate appropriations committees declined to comment on the reported \$200 million cut. NASA's space station budget was \$1.9 billion this year and the Bush Administration asked for \$1.8 billion this year. That doesn't include other costs, such as the shuttles' flights to the outpost or costs related to the experiments done on board. O'Keefe said the funding reduction would not cause a delay in any space station components or testing. However, should unexpected costs arise in the next 12 months, the agency would have very little cushion to fall back on, O'Keefe said. The space agency chief said NASA had complied with congressional directives to fix the space station project's dismal financial management practices. "We did everything we were instructed to do," he said. He said it was his understanding that lawmakers shifted the funding away from the station because the funds could be spared while station construction was halted due to the shuttle fleet's grounding. ["O'Keefe criticizes Congress over cuts," **Florida Today**, November 22, 2003, p 1A.]

November 22: 40 years ago today, President John F. Kennedy was assassinated in Dallas, Texas. Less than a week before President Kennedy died, he made a quick visit to Cape Canaveral to check on the progress of sending a man to the moon. It had been 2 ½ years since he first asked Congress to fund "the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth."

Kennedy's call also pushed NASA to acquire more land to complement the already busy Cape Canaveral Air Force Station. North Merritt Island, with its natural advantages and proximity to the Air Force site, was chosen over several other possible launch sites. On November 29, 1963, President Lyndon B. Johnson signed executive order #11129 renaming the facilities of the Launch Operations Center the John F. Kennedy Space Center. Today, Kennedy Space Center, including the Merritt Island Wildlife Refuge, encompasses 140,000 acres of land and water. ["JFK's vision reshaped Brevard," **Florida Today**, November 22, 2003, p 1A & 5A. Johnson, Lyndon B. (1963). Executive Order #11129.]

◆ Now is the best time in the last 30 years for the United States to craft a new vision for its space program, NASA Administrator Sean O'Keefe said this week. O'Keefe, speaking Tuesday in Washington at a Capitol Hill forum organized by the Aerospace States Association (ASA) on the need for a national space vision, said that a confluence of events made today one of the best times since the end of the Apollo program to reshape the nation's space program. "This is a rare moment in our history," O'Keefe said when asked about the development of a new national space policy. "Right now has never been more opportune. In the course of the last 30 years we've seen very few instances where it's lined up this carefully." O'Keefe didn't specify what combination of events led him to think this was an opportune time to develop a new space vision, but the Columbia accident and the soul-searching in its aftermath is thought by most observers to be central to the debate over a new space policy. The need for a bold new national space vision has been a major topic of debate and speculation within space policy circles in Washington in recent weeks. Last year the Bush Administration started a "phased review" of national space policy, looking at specific areas of the existing national space policy. To date, though, that effort has generated only a single new policy, on commercial remote sensing, issued in April. There have been indications, though, that the Bush Administration is pushing development of a new overall space policy. O'Keefe first mentioned the existence of an interagency group working on this policy during a Congressional hearing in September, and mentioned that Vice President Dick Cheney was leading that effort. Few other details about the new policy, including both its content and when it will be released, have come out since then, although some rumors suggest that the group is looking at taking national space efforts in a bold new direction, including possible human missions to the Moon or Mars. An announcement could come as soon as next month, at the 100th anniversary celebrations of the Wright Brothers' first flight at Kitty Hawk. One of the problems with developing a new vision for the space program that can serve as the basis for a new policy is that there is little consensus about what direction the space program should go. "There has always been unanimous agreement on the proposition that we must have a vision for what that next set of objectives should be, and no two people can agree on what it ought to be," he said. "This has been the continuing debate that has dominated society for 30 years." While President Bush is not believed to be actively engaged in the formulation of the policy, O'Keefe suggested in his comments that Bush is considering some space policy alternatives. "The President is working through a lot of different options and alternatives right now," O'Keefe said. "That's what he is deliberating on." Web posted. (2003). [O'Keefe: time is right for new space vision [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, November 22].]

November 24: NASA is considering a plan to retire its aging space shuttles around 2010 and convert any remaining orbiters into unmanned cargo carriers. The agency also might decide to get out of the shuttle business at that time, relying instead on new space taxis and freighters to fly crews and cargo to and from the International Space Station. The internal debate on the future of the shuttle fleet comes in the wake of the Feb. 1 Columbia disaster and the subsequent call to retire the ships as soon as practical. "Certainly no decisions have been made," said Gary Martin, head of the space architecture office at NASA headquarters in Washington. This much, however, is certain: NASA intends to fly its three shuttles until the U.S. core of the station is complete and components built by international partners have been added to it. That means Discovery, Atlantis and Endeavour likely will fly another two dozen missions during the next five or six years. "It's clear that in the near-term and for the foreseeable future . . . there really aren't any other options rather than returning the space shuttle fleet to flight and completing (station) assembly," said Michael Kostelnik, NASA's deputy shuttle and station chief. During its seven-month probe, the Columbia Accident Investigation Board determined the shuttle is an inherently risky vehicle. Fourteen astronauts and two \$2 billion shuttles have been lost in 113 flights during the past 22 years. Moreover, the investigators found the shuttle relies on now-obsolete technologies, and that it still should be considered an experimental test vehicle. Those facts led investigators to what they called an inescapable conclusion: "It is in the nation's interest to replace the shuttle as soon as possible as the primary means for transporting humans to and from

Earth orbit," the board said in its final report. Senior NASA managers and engineers, consequently, are examining options for a decade of station operations after construction is complete. The strategy includes development of a four-passenger orbital space plane and a heavy-lift cargo rocket that could haul up station equipment or hardware needed to stage missions to the moon or Mars. "We always want to keep in mind that the space station is not the final destination for us," said John "Row" Rogacki, NASA's director of space transportation technology. "So as we begin to formulate our plans for exploration, we need to just keep that in the back in our minds." NASA's planned Orbital Space Plane likely will serve as the primary U.S. means of transporting crews to and from the station once assembly is finished. Now envisioned either as an Apollo-like capsule or a smaller orbiter-like vehicle, the space taxi would launch on Delta 4 or Atlas 5 rockets from Cape Canaveral Air Force Station. The cost to develop the new vehicle: between \$11 billion and \$13 billion. A request for industry proposals is expected this week. A winning bidder is to be selected next August. ["NASA may shift focus to making space taxis," **Florida Today**, November 24, 2003, p 1A & 2A.]

◆ The National Aeronautics and Space Administration said Monday it is facing a bill of 432 million dollars to meet the costs of the Columbia shuttle crash investigation and to upgrade future shuttle missions. NASA said it would have to spend another 280 million dollars to get its space shuttles ready to fly again after the Columbia disaster, according to figures released Monday. However, the agency said it is also facing an additional bill of 152.4 million dollars to cover the costs of the recovery effort and the investigation into the Columbia shuttle disaster on February 1 that killed seven astronauts returning to earth. NASA said it would have to spend 235 million dollars by the end of next year on alterations to the shuttle launch system. Another 45 million dollars would be spent on a new engineering and safety center. The most expensive changes will be to the external fuel tank that was at the centre of the Columbia disaster. A piece of isolation foam on the tank came off during launch and pierced the Columbia's protective skin, letting in boiling hot gases that led to the vessel's breakup as it re-entered the Earth's atmosphere. The modifications to the fuel tank will cost 65 million dollars. Another 57 million dollars will be spent on changes to allow astronauts to carry out repairs while the shuttle is in orbit. Forty-four million dollars will be spent on a camera system to monitor possible problems after launch. The 280 million dollars does not take account of changes already decided by NASA, which was strongly criticized by the official inquiry into the accident. Web posted. (2003). [NASA facing 432 million dollar bill for shuttle disaster, equipment upgrades [Online]. Available WWW: <http://www.spacedaily.com/> [2003, November 24].]

November 25: In one of several stern directives to NASA, congressional budget-writers are suggesting that it slow down plans for an orbital space plane until there is a broader vision for the troubled agency. As part of a massive federal spending bill produced by House and Senate negotiators, lawmakers expressed concern that the proposed spacecraft may not fit in after that broader vision is established. "The orbital space plane program is expected to represent a significant investment by the American taxpayers if it is carried out to completion," lawmakers wrote. "It is therefore necessary that NASA manage this program unlike any it has ever executed or tried to execute in the past." Over all, the budget proposal includes \$15 billion for NASA in 2004, less than \$100 million more than the agency received in fiscal 2003. A \$200 million cut in the international space station program, proposed by the Senate in September, stayed in, but the bill also includes more than \$200 million in pet projects added by lawmakers. House and Senate budget negotiators also ordered NASA to submit a comprehensive plan to respond to the Columbia Accident Investigation Board's report and other problems in the agency by Jan. 15. That plan is supposed to include a 10-year funding blueprint as well. Lawmakers also mandated that the agency direct \$15 million to study crew survivability on the space shuttle and future spacecraft. ["NASA told to slow space-plane plans," **Orlando Sentinel**, November 26, 2003, p A5.]

November 29: The Visitor Complex at Kennedy Space Center hopes to give tourists a shuttle "immersion experience" with a new attraction that could open as soon as 2006. In a year when attendance has continued a decline that began after the terrorist attacks of 2001, the Visitor Complex is seeking to recreate the boost it got when it opened its Apollo/Saturn 5 Center in 1996. That exhibit helped boost attendance 14 percent in one year, said Dan LeBlanc, chief operating officer for Visitor Complex contractor Delaware North Parks Services. "If you open attractions properly, and you put the right kind of support behind them, the increase is permanent," LeBlanc said. "... That's why this is so important to us." The KSC Visitor Complex has seen a 25 percent to 30 percent dip in attendance since 9/11, Delaware North's Tracy Rogge told the Florida

Space Authority board of directors during its meeting this month. LeBlanc blames lower attendance on the uncertainty generated by the Iraq war. In addition, the Columbia accident led to a hiatus in shuttle launches, each of which can bring in 10,000 guests from launch to landing. The Orlando competition also is dipping into KSC's well. Walt Disney World recently opened the "Mission: Space" attraction at Epcot Center. It creates the feeling of a space launch and journey. Disney won't reveal how much "Mission: Space" cost, though outsiders say it may have been three times the \$50 million Delaware North expects to spend on the shuttle attraction. "What you can't spend in money, you have in credibility and location," LeBlanc said. What makes the KSC Visitor Complex different is its devotion to reality, LeBlanc said. "We're here to tell the NASA story . . . It has to be accurate, an accurate representation of what NASA is." Delaware North has been pondering what its next exhibit would be for more than a year. While it has narrowed its options to the shuttle-themed attraction, the idea is still conceptual. In other words, the company won't release details, NASA hasn't given its approval, and the necessary loans are still in the works. NASA has "a ton" of input when it comes to developing attractions for the Visitor Complex, LeBlanc said. "We work hand-in-hand with them on designing anything new, whether it's updating exhibits or how we want to tailor the message to the public," said Lisa Malone, a NASA spokeswoman at Kennedy Space Center. ["KSC hopes shuttle ride will draw crowds." **Florida Today**, November 29, 2003, p 1A & 2A.]

November 30: The "bold agenda for space exploration" that the Bush administration has been crafting since August is expected to be long on rhetoric but short on new goals and money. Internal NASA documents obtained by the *Orlando Sentinel* and interviews with those close to the policy-making process indicate the new vision being drafted for the National Aeronautics and Space Administration looks a lot like the old one. No final decisions have been reached. However, closed-door meetings of administration officials, including Vice President Dick Cheney, appear to be developing plans committed to the status quo, with no major new programs or specific destinations, no timetables and most importantly, no significant spending increases. This business-as-usual approach is cloaked in vague, soaring prose, such as the following "Prospective POTUS [President of the United States] Vision Statement" from an internal NASA document prepared for the White House: "A house with no foundation falls, and a journey without a plan traps us in the wilderness. To move America and the world boldly into our greatest frontier we must build the foundations of mind, technology and experience. Without them, our journey into space would be only a visit. With them, we can stay. Our children will lead us, and their adventure will have no end." That adventure will begin, however, with a stagnant 2004 NASA budget -- funding is expected to rise slightly from just more than \$15.4 billion in 2003 to about \$15.5 billion -- and continue with the same human-spaceflight programs that have been the agency's focus for more than a decade: the shuttle and the international space station. Likewise, incremental research will proceed on projects to develop nuclear rocket propulsion and a small orbital space plane that would ferry people and cargo to the station. There are no concrete plans to go to Mars, return to the moon or otherwise extend manned spaceflight beyond low Earth orbit. In fact, NASA may squeeze existing programs to help raise an estimated \$280 million needed to return the space shuttle to flight after the Feb. 1 Columbia disaster. "I don't think they have the courage to candidly characterize the present situation," said John Pike, director of the public policy-research organization GlobalSecurity.org. "Namely, that we have a precarious fingerhold in space. But we're not exactly sure where we're going to go next or when we're going to go there." The administration's all-too-familiar road map follows a call by the Columbia Accident Investigation Board in August for a national debate on U.S. space goals. There also is renewed interest in Congress, on a scale not seen in years, to pursue a shuttle successor or other projects. Despite assurances from the White House and NASA political appointees that the president is deeply committed to space exploration, there is no indication President Bush is willing to spend money on new programs in a time of soaring budget deficits. The accident board noted in its final report that how well a program is funded is a direct reflection of the importance placed on it. Web posted. (2003). [NASA's new plan looks like old one [Online]. Available WWW: <http://www.orlandosentinel.com/> [2003, November 30].]

◆ NASA Orbital Space Plane is touted as the nation's net space vehicle aimed at providing crew rescue and transfer for the international Space Station. If given a go-ahead, the project will serve as needed backbone, quite literally, to spearhead the rekindling of human space venturing beyond low Earth orbit. Whether the Orbital Space Plane is a winged craft, a capsule, or some sort of cross between the two remains on the table. Regardless of the approach, the concept already faces criticism. For supporters, OSP is a fast-track way to assure safe flight of the astronauts to and from the ISS and to help maximize the

scientific output of the costly orbiting complex. Others see OSP as merely an expensive ploy not to buy Russian Soyuz capsules. The OSP is to be compatible with both of the United States' Evolved Expendable Launch Vehicle systems, Atlas 5 and Delta 4. Projected cost of the OSP effort, through 2009, is \$11 billion to \$13 billion. ["Launch abort will test space plane," **Florida Today**, November 30, 2003, p 1C.]



The orbiter Atlantis is towed back to the Orbiter Processing Facility after spending 10 days in the Vehicle Assembly Building. The hiatus in the VAB allowed work to be performed in the OPF that can only be accomplished while the bay is empty. Work included annual validation of the bay's cranes, work platforms, lifting mechanisms and jack stands. Work resumes to prepare Atlantis for launch in September 2004 on the first return-to-flight mission, STS-114.

DECEMBER

December 1: The system NASA uses to decide how much to pay shuttle contractor United Space Alliance is loaded with loopholes that help the company get the maximum bonus and could discourage workers from reporting safety problems, according to a study conducted for Columbia accident investigators. The study's findings and recommendations did not make it into the Columbia Accident Investigation Board's final report, in part because researchers said they found no proof the shuttle contract incentives inhibited safety or had anything to do with the Feb. 1 disaster. NASA's biggest contractor, a partnership of The Boeing Co. and Lockheed Martin Corp., said that six-plus years of performance measures show the contract enhances safety. Spokesman Jeff Carr said USA welcomes scrutiny of the Space Flight Operations Contract, or SFOC. "We're not married to this award fee structure," Carr said. The review, conducted by contractor Valador Inc. for Columbia investigators, was released this month among hundreds of pages of supporting documents compiled during the seven-month probe. The documents are marked as work material, with a note that they are not official board findings. Overall, the contract review team found the award-fee system used in some shuttle contracts is "cumbersome and counterproductive." NASA said the accident board's conclusions are being considered in the agency's ongoing review of the Space Flight Operations Contract. The assessment began about a year ago, but was slowed by the shuttle accident, said Michael Kostelnik, the NASA manager in charge of the shuttle and space station programs. "We are actively considering how best to structure the SFOC to strengthen both the mission performance and safety of our Space Shuttle operation," he said. ["Loopholes fill shuttle deal," **Florida Today**, December 1, 2003, p 1A & 2A.]

December 2: A Lockheed Martin Atlas 2AS rocket carried out a clandestine mission in the predawn darkness today, deploying into space what is believed to be a package of ocean surveillance satellites to aid the U.S. government track suspicious ships in the global fight against terrorism. Lifting off right on time at 1004 GMT (2:04 a.m. local time; 5:04 a.m. EST), the 16-story tall booster slowly rose from its Space Launch Complex 3-East pad at Vandenberg Air Force Base, California. It marked the third and final Atlas 2AS vehicle to fly from the West Coast. About 74 minutes later, the secret National Reconnaissance Office payload was released from the Centaur upper stage to complete the launch, extending the Atlas rocket's string of successful missions to 67 over the past 10 years. Web posted. (2003). [Atlas soars on secret mission under cover of darkness [Online]. Available WWW: <http://www.spaceflightnow.com/> [2003, December 2].]

◆ Four NASA astronauts have been chosen to fly on the newly created Space Shuttle mission, STS-121. It is the mission following the Space Shuttle's Return to Flight. Veteran astronaut Steven W. Lindsey (Col., USAF) is the commander of STS-121. Mark E. Kelly (Cmdr., USN) is the pilot; Carlos I. Noriega (Lt. Col., USMC, Ret.) and Michael E. Fossum are the mission specialists. Other crewmembers will be named later. STS-121 was added to the flight schedule to help accommodate the growing list of requirements originally assigned to the Return to Flight mission. The crew will re-supply the International Space Station with equipment and consumables. They will also continue the testing and development of new hardware and procedures designed to make Space Shuttle flight safer. The crew recently began their pre-mission training together at NASA's Johnson Space Center, Houston. Initial activities focus on general procedural training on Shuttle and Station systems, preliminary spacewalk development and robotics training. ["NASA Names Crew for New Space Shuttle Mission," **NASA News Release #03-385**, December 2, 2003.]

December 3: At NASA's request, the Pentagon is using spy satellites to check the international space station for any exterior damage that might explain the loud metallic noise heard last week by the two men on board. The space agency learned a lesson from the Columbia disaster. "In everybody's minds, there is, 'OK, let's make sure we don't miss something.' They're keyed up, they're more attentive than they might otherwise be," said Charles Precourt, a space shuttle commander now serving as deputy manager of NASA's space station program. Precourt told The Associated Press on Wednesday that the Defense Department has used its technology to look at the orbiting outpost since the noise was reported on November 26. Because of the classified nature of the work, he would not say whether NASA has obtained any satellite or ground telescope images so far that shed light on the problem. But he said nothing amiss has been found. Web posted. (2003). [NASA asks Pentagon for space station help [Online]. Available WWW: <http://www.cnn.com/> [2003, December 3].]

◆ A massive International Space Station solar panel will be shipped back to Kennedy Space Center December 15th after passing post-shuttle Columbia tests aimed at ensuring it will spread open in orbit. Senior NASA managers ordered the tests, which were conducted in California, after it became clear the Feb. 1 Columbia accident indefinitely grounded the agency's shuttle fleet and significantly delayed station construction. The hiatus meant the power-producing panel would not be launched before its 45-month ground storage certification expired. The engineers worried that, after the long time, the solar array might not extend properly if parts of the folded-up panels stuck together. But officials said on Wednesday the tests proved the panel and others destined for the station can remain on the ground twice as long and still work as advertised in orbit. The tests also negated the need to send other panels back to their manufacturer, Lockheed Martin in Sunnyvale, Calif., as long as the shuttle fleet returns to flight as scheduled in mid-September of next year. "We don't foresee having to send another wing back, given the current projected launch dates," said Robbie Ashley, a NASA mission integration engineer at KSC. ["Solar panel KSC-bound," **Florida Today**, December 4, 2003, p 1B.]

December 4: President Bush and a team of top advisers are plotting a new vision for NASA, one that could include sending astronauts beyond Earth orbit to the moon with an eventual eye on Mars. The president's secretive review of U.S. space policy, prompted by the Feb. 1 Columbia tragedy that killed seven astronauts, also has looked at scaling back human spaceflight. However, the White House said Thursday not to expect any major announcement soon, dimming speculation that Bush might unveil a bold new vision for NASA on Dec. 17 during the celebration of the 100th anniversary of the Wright brothers first flight at Kitty Hawk, N.C. "It would be premature to get into any speculation about our space policy that has been and continues to be under review," White House Press Secretary Scott McClellan said. "There are no plans for any policy announcements in the immediate future, and that would include any upcoming speeches." NASA remained just as cagey Thursday amid widely varying published accounts of what President Bush is going to announce and when. "If and when the president is ready to make an announcement, he will do so," said Glenn Mahone, the top spokesman at the agency's headquarters in Washington. ["U.S. space vision stays secret," **Florida Today**, December 5, 2003, p 1A & 3A.]

◆ NASA's Office of Safety and Mission Assurance has signed an agreement with the Naval Sea Systems Command (NAVSEA) for each organization to participate in the engineering investigations and technical analyses of the other. NASA's Associate Administrator for Safety and Mission Assurance Bryan O'Connor signed the agreement Tuesday at NASA Headquarters in Washington. His counterpart, Gregg Hagedorn, NAVSEA's Executive Director for Ship Design, Integration & Engineering, signed for the Navy. ["NASA Engineering Investigations Get Navy Input," **NASA News Release #03-393**, December 4, 2003.]

December 5: Space Shuttle Atlantis was transferred from the Orbiter Processing Facility to the Vehicle Assembly Building on Friday at Kennedy Space Center. Atlantis will spend about 10 days undergoing maintenance in the Vehicle Assembly Building, and then return to the Orbiter Processing Facility for more work in preparation for a mission scheduled for September. It will be the 1st shuttle flight since the breakup of Columbia during re-entry from orbit on Feb. 1. ["Inching closer to launch," **Orlando Sentinel**, December 6, 2003, p A3.]

◆ Singer Patti LaBelle has been nominated for a Grammy for her rendition of "Way Up There." LaBelle was one of five nominees in the Traditional Rhythm & Blues category for the 46th Annual Grammy Awards. The song was originally commissioned by NASA to commemorate the Centennial of Flight. The yearlong commemoration has included events across America. It culminates at Kitty Hawk, N.C., on the anniversary of the Wright brothers' first powered flight, Dec. 17. LaBelle brought the song into national prominence, when she sang it at the first memorial service for the seven Space Shuttle Columbia astronauts. She sang "Way Up There" at the National Cathedral, Washington, on Feb. 6, just five days after the Columbia crew was lost, Feb. 1, 2003, while returning to Earth after completing their successful mission. LaBelle also performed the song at other events including opening day for the Houston Astros major league baseball team. The Astros, originally named for America's space program, honored the Columbia's crew during their home season opener on April 1. The Astros also decided to honor the astronauts by wearing the mission patch from Columbia (STS-107) on their uniforms during the 2003 season. LaBelle also performed the song at New York's Rockefeller Center in July to commemorate 100

years of flight. Tena R. Clark wrote the song. She received a modest honorarium from the NASA Art Program to compose the song for the Centennial of Flight. It appears as a track on LaBelle's "Church: Songs for Soul and Inspiration" on UTV Records and separately as a single "Way up There" on DMI Records. The 46th Grammy Awards will be presented in Los Angeles on Sunday, Feb. 8, 2004. . ["NASA Song Soars To Grammy Nomination," **NASA News Release #03-396**, December 5, 2003.]

December 8: A NASA astronaut set a new U.S. space record Monday, tallying more time in orbit than any other American. Now aboard the International Space Station, Michael Foale has chalked up more than 231 days in orbit during five shuttle missions, an expedition on Russia's former space station Mir and his current stay on the international space outpost. The British-born astrophysicist will have spent 372 days in space by the time he and current station crewmate, Russian cosmonaut Alexander Kaleri, return to Earth April 29 aboard a Russian Soyuz spacecraft. ["Foale's 231 days spent in orbit sets record," **Florida Today**, December 9, 2003, p 1A.]

December 9: In preparation for the repair necessary to the Gravity Probe B spacecraft, the payload attach fitting and solar arrays have been removed. A decision has been made that the cryogenic helium will not need to be offloaded from the spacecraft to remove the Experiment Control Unit (ECU), which is expected to occur Dec. 9. The return to the factory of the ECU is expected Thursday, Dec. 11. Meanwhile, at Space Launch Complex 2, the Boeing Delta II rocket remains at the pad, enclosed within the gantry-like mobile service tower, until the GP-B spacecraft arrives. While no new launch date has been established, a Flight Planning Board meeting is planned for mid-December, and the outcome could determine a possible target date or at least a new launch time frame. ["Gravity Probe B launch to be reviewed by Flight Planning Board," **KSC Countdown**, December 9, 2003.]

◆ About 24 Boeing workers face layoffs by late January as a result of the completion of ground testing on core U.S. components of the International Space Station, a company official said Tuesday. Boeing, however, is trying to place those workers in jobs at other company divisions. The company placed 48 of 72 workers who received layoff notices Nov. 21. And Boeing expects 32 positions to be transferred to Kennedy Space Center from Huntington Beach, Calif., in 2004. "With the success we've had in the last two weeks placing the 48, it's looking pretty good for everybody," said Tina Lange, a spokeswoman for Boeing Space Operations Co. In August, Boeing was awarded NASA's Checkout, Assembly and Payload Processing Services contract at KSC -- follow-on to a ground processing contract the company had for 15 years. The so-called CAPPS contract provides for management and technical support of payload processing for NASA's space shuttle and space station programs as well as expendable rockets and other projects. The four-year contract is valued at \$332 million. NASA can exercise two, three-year options. Doing so would bring the value of the pact to \$810 million across 10 years. As of late November, 947 people were employed under the contract. ["Boeing tries to place employees," **Florida Today**, December 10, 2003, p 1B.]

◆ The sight of three massive rockets lying side by side -- all, in fact, built together as the new Delta 4 Heavy -- prompts visions of a new kind of space shuttle. Boeing, which rolled the rocket out to its launch pad at Cape Canaveral Air Force Station on Tuesday, has those visions. So does Lockheed Martin. Either contractor might be the one to launch the still-in-development orbital space plane on one of its new rockets. Delta program manager Dan Collins said Boeing's head start is likely to give it an advantage when it comes to bidding on a new ship to take people to and from the International Space Station. "We'll have at least three launches by the time that competition rolls into town," Collins said. " . . . I think it's a real advantage for the engineers and the overall community to have actual flight data." After months of system, electrical and fueling tests, Boeing will launch the heavy version of its Evolved Expendable Launch Vehicle first, on a test flight in July. Two more heavy flights are contracted for 2005. Lockheed Martin's Atlas 5, also developed under the Air Force's EELV program, will have a heavy-lift version ready in the third quarter of 2006, spokeswoman Julie Andrews said. Both contractors are developing proposals for the orbital space plane, which could be flying around the end of this decade. They're talking with NASA about what they need to do to meet requirements set out by the agency. Those include what it will take to prove the Delta 4 Heavy is safe enough to carry humans to orbit, Collins said. Andrews said that it's possible a non-heavy Atlas 5 would be able to do the job. Both contractors are waiting for NASA to release its official Request

for Proposal for the space plane, though they've been working from a draft as they develop their designs. ["Boeing rolls out bigger rocket," **Florida Today**, December 10, 2003, p 1A & 3A.]

December 11: As NASA struggles to improve its safety oversight after the Columbia shuttle disaster, its inspector general warned Thursday that the agency's preliminary plans will not accomplish what accident investigators intended. In an advisory memo to NASA Administrator Sean O'Keefe, NASA's Inspector General Robert Cobb said his office has been reviewing NASA's progress in responding to recommendations of the Columbia Accident Investigation Board regarding the need for a new Independent Technical Engineering Authority. The authority, outlined in the board's report on the Feb. 1 accident, is to be responsible for all the technical and safety requirements for the shuttle flights, and any waivers to them. The board was adamant that NASA separate that authority from concerns about keeping shuttle flights on schedule and under budget -- pressures that threaten to compromise shuttle safety. The inspector general said NASA appears to be devising a plan to make its field centers responsible for fulfilling independent engineering and safety responsibilities, with policy direction and oversight coming from the agency's Washington headquarters. Cobb said that approach is "inconsistent with the language of the CAIB report." The CAIB thought of the technical authority as a "single integrated authority" rather than separate organizations scattered around the country and reporting to NASA's center directors, as NASA is contemplating, Cobb said. The accident investigators also recommended that the safety organization would report directly to Bryan O'Connor, the associate administrator for safety and mission assurance at NASA headquarters. But Cobb said NASA's plans don't follow that recommendation. "To us, adapting the independent engineering and safety organizations into NASA's decentralized (center oriented) and matrixed structure would not create a system of checks and balances able to withstand the test of time," he wrote. Cobb also warned that if NASA intends to deviate from the express language of the CAIB report, it should "state openly and clearly its reasons for doing so," including explaining why following the board's instructions would not be in the best interests of NASA. O'Connor released a statement saying NASA is "still midstream in the development of our implementation plan." "When established, NASA's independent technical authority will apply not only to the space shuttle program, as the Columbia Accident Investigation Board has recommended, but also all programs and projects throughout the agency, as Administrator O'Keefe has directed," he said. "We'll certainly consider the inspector general's comments as we proceed." NASA's Return to Flight Task Group, which also is overseeing the agency's compliance with the accident board's recommendations, reviewed plans for the technical authority during a three-day session in Houston this week. Dan Crippen, who chairs the task group's subcommittee on shuttle management reform, said Thursday NASA needs more time to arrive at the proper formula that could be used throughout the Agency. Web posted. (2003). [NASA's safety planning criticized [Online]. Available WWW: <http://www.HoustonChronicle.com/> [2003, December 11].]

◆ NASA is looking at lining the inside of shuttle wing panels with sensors to detect the type of damage that doomed Columbia and its astronauts. That change and other new safety measures, however, likely will make it difficult for NASA to launch its first post-Columbia flight as planned next September. "I don't think the space shuttle program thinks right now that they don't have some issues that are out there that may preclude being able to fly in the September-October window they are using as a planning date," said Richard Covey. A former NASA astronaut, Covey chairs a group overseeing agency efforts to implement the recommendations of the Columbia Accident Investigation Board. The board traced the Feb. 1 disaster to a chunk of external tank foam insulation striking a panel on the shuttle's left wing 82 seconds after a Jan. 16 launch. Investigators said the foam gouged a six- to 10-inch hole in the panel, allowing hot gases to penetrate the wing and rip the ship apart during atmospheric reentry. Panel member Joseph Cuzzupoli said NASA might install instrumentation behind 22 thermal panels that protect each wing from intense heat during re-entry. The sensors would detect and measure the force of a debris hit. That would enable astronauts to focus cameras on trouble spots during orbital inspections required on future flights. ["Shuttle-wing sensors considered," **Florida Today**, December 12, 2003, p 1B.]

December 12: Lottery players don't want the moon and the stars -- just the money, Florida officials decided as they rejected a proposal to offer spaceflight as a big prize. The idea of winning a ride on a Soyuz spacecraft to the international space station just didn't appeal to lottery players, Bob Nave, chief of staff of the Florida Lottery, said Friday. "It was an intriguing enough concept to present to our focus groups ... but people like to win cash." The space lottery idea had been championed by Space Adventures, an Arlington,

Virginia-based company that has a contract with the Russian space agency for two seats on a Soyuz flight. Web posted. (2003). [Florida lottery rejects spaceflight prize [Online]. Available WWW: <http://www.cnn.com/> [2003, December 12].]

December 15: A rocket set to launch tonight will complete a constellation of Navy satellites that lets soldiers communicate through jungle thickets or heavy thunderstorms. "UFO" -- ultra high-frequency follow-on -- satellites allow people in all branches of the military to talk securely between the ground, ships and airplanes. "Right now, there are about 20,000 UHF satellite terminals currently in use," Navy spokesman Steve Davis said. The launch window for the Lockheed Martin Atlas 3 rocket on Pad 36B extends from 9:38 to 11:38 p.m. The weather for tonight's launch looks good, with a better than 90 percent chance of favorable skies, the 45th Weather Squadron predicts. Winds are the only concern. If the launch is delayed, the chance of good weather goes down to 80 percent for Tuesday and is 60 percent for Wednesday, forecasters say, as rain returns in advance of another cold front. Web posted. (2003). [Rocket to carry last "UFO" satellite [Online]. Available WWW: <http://www.floridatoday.com/> [2003, December 15].]

December 16: The orbiter Atlantis is scheduled to return to the Orbiter Processing Facility today. Rollover from the VAB begins at 8 a.m. Atlantis spent 10 days in the VAB to allow work to be performed in the OPF that can only be accomplished while the bay is empty. Work included annual validation of the bay's cranes, work platforms, lifting mechanisms and jack stands. Work resumes to prepare Atlantis for launch in September 2004 on the first return-to-flight mission, STS-114. ["Atlantis's rest over, work resumes for return to flight," **KSC Countdown**, December 16, 2003.]

◆ Another ELV launch scheduled in early 2004 is a NASA mission, to study the Earth's ozone, air quality and climate. Known as Aura, the mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere, employing multiple instruments on a single satellite. Aura is the third in a series of major Earth Observing System (EOS) satellites to study the environment and climate change and is part of NASA's Earth Science Enterprise. The first and second missions, Terra and Aqua, are designed to study the land, oceans, and the Earth's radiation budget. Aura's chemistry measurements will also follow up on measurements that began with NASA's Upper Atmospheric Research Satellite and continue the record of satellite ozone data collected from the TOMS missions. ["2004 EOS launch Aura to study Earth's ozone, air quality and climate," **KSC Countdown**, December 16, 2003.]

December 17: One-hundred years after the Wright brothers' first flight, an attempt to re-create the moment failed Wednesday when a replica craft couldn't get off the ground and sputtered into the mud. A cheer rose from the crowd of 35,000 when the muslin-winged flyer roared to life and began moving down a wooden launch track. But that cheer suddenly turned to a groan when the rickety craft stopped dead in a muddy puddle at the end of the track. Though disappointing, the failed first try at a re-enactment was not historically inaccurate. The Wrights also crashed their Wright Flyer, three days before finally getting it off the ground. ["Wind stiffens Wright replica," **Florida Today**, December 18, 2003, p 3A.]

◆ The last star in a constellation of satellites used by soldiers in the field launched into a cold, starry night Wednesday. The Navy's Ultra-High-Frequency Follow-On, or UFO, was the 11th and final in a series of secure communications satellites. The Lockheed Martin Atlas 3B rocket lifted off at 9:30 p.m. from Cape Canaveral Air Force Station. The satellite successfully separated from the rocket about a half-hour later. Its orbit will be lifted over the next few weeks, Boeing Satellite Systems' Dave Ryan said. Web posted. (2003). [Atlas lofts military probe into orbit [Online]. Available WWW: <http://www.floridatoday.com/> [2003, December 17].]

December 18: The Audubon Society's annual Christmas bird counts in the 140,000 acre Merritt Island National Wildlife Refuge found 10 fewer species than last year, when there were 157 different types. Both waterfowl and songbird numbers seem to be down. "It is the lowest count here that I can remember," said Dorn Whitmore, chief ranger at the refuge. ["Silence rules where there used to be songbirds," **Orlando Sentinel**, December 19, 2003, p A1 & A5.]

◆ NASA Administrator Sean O'Keefe today announced NASA's Space Infrared Telescope Facility has been renamed the Spitzer Space Telescope. It was named in honor of the late Dr. Lyman Spitzer Jr., one of the 20th century's most distinguished scientists. Spitzer's pioneering efforts to put telescopes in space led to two successful space missions, including the Hubble Space Telescope. NASA also released the telescope's first dazzling observations. "The Spitzer Space Telescope takes its place at the forefront of astronomy in the 21st century, just as its namesake, Dr. Lyman Spitzer Jr., was at the forefront of astronomy in the 20th," said NASA's Associate Administrator for Space Science Dr. Ed Weiler. The telescope was launched August 25, 2003, from Cape Canaveral Air Force Station, Fla. The Spitzer Space Telescope uses state-of-the-art infrared detectors to pierce the dense clouds of gas and dust that enshroud many celestial objects, including distant galaxies; clusters of stars in formation; and planet forming discs surrounding stars. It is the fourth of NASA's Great Observatories, a program that also includes the Hubble Space Telescope, Chandra X-ray Observatory and the Compton Gamma Ray Observatory. ["NASA Announces New Name For Space Infrared Telescope Facility," **NASA News Release #03-414**, December 18, 2003.]

December 19: NASA agreed to a \$40.2 million modification to the Space Flight Operations Contract with United Space Alliance in support of the Space Shuttle Cockpit Avionics Upgrade (CAU). The modification settles a request for equitable adjustment made by United Space Alliance related to a variety of changes in the development of the CAU. This upgrade is planned to enhance the Space Shuttle cockpit with more intuitive displays that increase the crew's situational awareness and reduce pilot workload during critical phases of flight. The adjustment covers new requirements for flight hardware burn-in, independent assessment support, additional display computations, test and evaluation changes, and delays in the authority to proceed, as well as other efforts in support of the previously authorized CAU. The negotiated equitable adjustment was settled with an increase in cost of \$40.2 million to the \$12.9 billion Space Flight Operations Contract held by United Space Alliance. Work on this effort is performed at facilities in Houston and the Kennedy Space Center, Fla. Major subcontractor facilities are located in Huntington Beach, Calif. and Oswego, N.Y. ["NASA, United Space Alliance Agree To Contract Adjustment," **NASA News Release #03-419**, December 19, 2003.]

December 21: A new navigation satellite is in space and is expected to be helping soldiers, drivers, boaters and hikers in less than a month. The Global Positioning System satellite, built by Lockheed Martin, was hoisted into a clear, cold night by a Boeing Delta 2 rocket at 3:05 a.m. EST today from Complex 17A. ["GPS satellite reaches orbit," **Florida Today**, December 22, 2003, p 1B.]

December 22: On Christmas Eve, when Santa Claus slips into NASA-Kennedy Space Center airspace under cover of darkness, a radar controller at the Shuttle Landing Facility (SLF) will be following his every move from a brand new, state-of-the-art traffic control tower. "We've been in contact with Santa, although for security reasons I can't elaborate," said Ron Feile, lead air traffic controller with Space Gateway Services (SGS). "Santa knows about the control tower, and he's very pleased that he can help us give it a shakedown." SLF employees look forward to working in the new facility. It replaces a control tower that has been in use since 1987. Located just south of the SLF's midpoint, the old tower stands only 20 feet above the runway surface, too low to see the launch pads to the east. During nighttime landing operations, those inside the tower are hindered by the eight-billion candlepower xenon lights that illuminate the runway. Built atop an existing mound, the new control tower rises nearly 100 feet over the midpoint of the runway, giving controllers a spectacular 360-degree view of NASA-KSC and northern Brevard County. The new facility will also replace the SLF Operations Building. The operations building is home to the Military Radar Unit that monitors NASA-KSC airspace 24 hours a day, as well as runway light controls, navigational aids, weather and wind speed instrumentation, and gate controls. In the new tower, the computer displays will be fully modernized to Federal Aviation Administration standards with touch-screen technology. From a weather station located in a wooded area east of the runway, KSC weather is also monitored 24 hours a day. From this area, the SLF is not even visible. When the new tower opens, those who monitor the weather will move in first, giving up their remote station in favor of the new, high-tech facility. Construction on the new facility began in February 2003 and is nearly ready for occupancy. Only some final inspections and approvals remain. A support building and Public Affairs viewing deck, to be used for observing future landing operations, will be added and are already in work. ["Santa To Help Test New Control Tower," **KSC News Release #99-03**, December 22, 2003.]

December 24: A NASA veteran was named Tuesday to run the office that is getting the space shuttle's external fuel tank - a key element in the Columbia tragedy - ready to return to flight. Sandra C. Coleman will be responsible for all development and manufacturing of the huge orange tanks, which are overseen by the Marshall Space Flight Center in Huntsville, the facility announced. Coleman replaces Jerry Smelser, who requested reassignment after the Columbia tragedy and is retiring at the end of the year. Dense foam peeled off Columbia's external tank during launch, striking the shuttle's left wing and causing damage that investigators blamed for its breakup during re-entry on Feb. 1. Web posted. (2003). [NASA veteran named to head office with oversight of shuttle's external tank [Online]. Available WWW: <http://www.floridatoday.com/> [2003, December 24].]

December 27: The future of forecasting may lie in the pieces workers are gingerly removing from a weather satellite that crashed to the factory floor. NOAA N Prime is strapped in place where it fell in September, on the floor of the Lockheed Martin plant in Sunnyvale, Calif. It was due to launch in 2008, but it's likely several months will go by before the government knows whether it can be saved. It's a key satellite in the constellation of eyes in the sky that help predict hurricanes, record climate trends, identify forest fires and aid search-and-rescue efforts. It's also the last weather sentinel to launch before the deployment of a new system designed to combine civilian and military functions. Web posted. (2003). [Satellite mishap may mean gaps in weather forecasts [Online]. Available WWW: <http://www.floridatoday.com/> [2003, December 27].]

December 31: NASA has extended a primary contract for the International Space Station for On-Orbit Acceptance and Vehicle Sustaining services to The Boeing Company of Houston. Work under the contract extension will provide delivery, on-orbit acceptance, sustaining engineering and postproduction support for hardware and software of the U.S. segment of the Station, and for common hardware and software provided to the International Partners and Participants. The work also will include providing management of the majority of Space Station subsystems and specialty engineering disciplines such as materials, electrical parts, environments and electromagnetic effects. The basic period of the cost-plus-award-fee contract extension is two years and nine months with an estimated value as much as \$1 billion. Four six-month options are available and, if fully exercised, could bring the total contract value to \$1.62 billion. Work on the contract will be performed at NASA's Johnson Space Center in Houston, NASA's Kennedy Space Center in Cape Canaveral, Fla., NASA's Marshall Space Flight Center in Huntsville, Ala., as well as in other locations inside and outside of the United States. This extension was awarded as part of a restructuring of Station contracts. The goal is to consolidate work, increase efficiency, increase accountability, and transition the program's contract strategy from development and construction of hardware to orbital operations. ["NASA Extends Space Station Contract With Boeing," **NASA News Release #c03-yy**, December 31, 2003.]

During December: Members of the NASA Advisory Council (NAC) with deep experience in human spaceflight and its shortcomings remain skeptical that the agency is fixing the "cultural" problems blamed in the Columbia accident. Retired Sen. John Glenn (D-Ohio) complained that inappropriate safety waivers were behind all three fatal accidents in the U.S. human spaceflight program, while Roger E. Tetrault - an engineer who investigated the Columbia accident - reported the shuttle program carries 1,500-1,800 waivers. A. Thomas Young, who has reviewed NASA programs as diverse as the failed 1998 Mars probes and the International Space Station, worried that waivers put astronauts into environments that have never been tested. "If you do that you're not taking risks, you're gambling," Tetrault said he told Administrator Sean O'Keefe he should be embarrassed that the 13 outsiders on the accident investigation panel, and not NASA itself, found a potentially deadly flaw in the device designed to keep 40-lb. separation bolts from hitting the orbiter on ascent. O'Keefe said the cultural issues should be addressed by the next NAC meeting in March 2004. And John H. Casper, a former astronaut and human spaceflight manager, stressed that engineering and operational fixes already being installed will make the next shuttle flight much safer than those before the accident. ["Not so fast," **Aviation Week & Space Technology**, December 15, 2003, p 17.]

◆ NASA has completed tests on rocket engines and parachutes for its Pad Abort Demonstration testbed, which seeks to validate technology for a crew escape system that could save an Orbital Space Plane crew if its launch vehicle fails on liftoff. The 50,000-lb thrust RS-88 engine that will power the demonstrator was

tested 14 times for a total of 55 sec., while the 80-ft. drogue and four 156-ft main parachutes were tested with a 12.5-ton pallet dropped from 10,000 ft. ["World News Roundup," **Aviation Week & Space Technology**, December 22, 2003, p 19.]

Appendix A

Mission Payload	<u>Vehicle</u>	<u>Launch Site</u>	Launch Date	Customer
<u>SIRTF</u>	<u>Delta II Heavy</u>	CCAFS	25 August 2003	<u>NASA-JPL</u>
<u>SCISAT</u>	<u>Pegasus XL</u>	VAFB	12 August 2003	NASA-GSFC/ <u>CSA</u>
<u>MER-B Opportunity</u>	<u>Delta II Heavy</u>	CCAFS	7 July 2003	<u>NASA JPL</u>
<u>MER-A Spirit</u>	<u>Delta 7925</u>	CCAFS	10 June 2003	<u>NASA JPL</u>
<u>GALEX</u>	<u>Pegasus XL</u>	CCAFS	28 April 2003	<u>NASA JPL/GSFC</u>
<u>SORCE</u>	<u>Pegasus XL</u>	CCAFS	25 January 2003	NASA GSFC
<u>ICESAT and CHIPSAT</u>	<u>Delta II</u>	VAFB SLC-2	12 January 2003	NASA GSFC

Web posted. (2003). [ELV Archives [Online]. Available WWW: <http://www.ksc.nasa.gov/> .]

Appendix B

COLUMBIA

Space Shuttle Columbia was named after a sailing frigate launched in 1836 that circumnavigated the globe under the command of Robert Gray. The Apollo 11 Command Module was also named Columbia.

Spacecraft dates for OV-102, Space Shuttle Columbia

July 26, 1972
Contract Award

March 27, 1975
Start long lead fabrication aft fuselage

November 17, 1975
Start long-lead fabrication of crew module

June 28, 1976
Start assembly of crew module

September 13, 1976
Start structural assembly of aft-fuselage

December 13, 1976
Start assembly upper forward fuselage

January 3, 1977
Start assembly vertical stabilizer

August 26, 1977
Wings arrive at Palmdale from Grumman

October 28, 1977
Lower forward fuselage on dock, Palmdale

November 7, 1977
Final assembly of OV-102 started at Rockwell International assembly facility, Palmdale, California.

February 24, 1978
Body flap on dock, Palmdale

April 28, 1978
Forward payload bay doors on dock, Palmdale

May 26, 1978
Upper forward fuselage mate

July 7, 1978
Complete mate forward and aft payload bay doors

September 11, 1978
Complete forward RCS

February 3, 1979
Complete combined systems test, Palmdale

February 16, 1979
Airlock on dock, Palmdale

March 5, 1979
Complete postcheckout

March 8, 1979
Closeout inspection, Final Acceptance Palmdale

March 8, 1979
Rollout from Palmdale to Dryden Flight Research Center (38 miles)

March 12, 1979
Overland transport from Palmdale to Edwards

March 20, 1979
Shuttle Carrier Aircraft Ferry Flight from DFRF to Biggs AFB, Texas

March 22, 1979

SCA ferry flight from Biggs AFB to Kelly AFB, Texas
 March 24, 1979
 SCA ferry flight from Kelly AFB to Eglin AFB, Florida
 March 24, 1979
 Arrival at Kennedy Space Center atop Boeing 747 Carrier Aircraft from Eglin, AFB.
 November 3, 1979
 Auxiliary Power Unit hot fire tests, OPF KSC
 December 16, 1979
 Orbiter integrated test start, KSC
 January 14, 1980
 Orbiter integrated test complete, KSC
 November 24, 1980
 Columbia was transferred from OPF to VAB for mating with ET & SRBs for STS-1 flight.
 December 29, 1980
 Mated STS-1 transported from VAB to LC-39A.
 February 20, 1981
 Columbia's flight readiness firing of three main engines lasted 20 seconds.
 April 12, 1981
 Columbia launched on its first flight, STS-1.
 April 14, 1981
 Columbia landed at EAFB on runway 23 to complete STS-1 mission.
 April 20, 1981
 Columbia atop 747 carrier aircraft ferried from EAFB to KSC.
 April 21, 1981
 Columbia moved to OPF to prepare for second flight.
 August 4, 1981
 Columbia transferred from OPF to VAB for mating.
 August 26, 1981
 Mated STS-2 transported from VAB to LC-39A.
 November 12, 1981
 Columbia launched on its second flight, STS-2.
 November 14, 1981
 Columbia landed at EAFB on runway 23 to end STS-2 mission.
 November 24, 1981
 Columbia ferried from EAFB to KSC.
 November 25, 1981
 Columbia at OPF to prepare for third flight.
 February 3, 1982
 Columbia transferred from OPF to VAB for mating.
 February 16, 1982
 Mated STS-3 transported from VAB to LC-39A.
 March 22, 1982
 Columbia launched on third flight, STS-3.
 March 30, 1982
 Orbiter Columbia landed at Northrup Strip, White Sands Missile Range, New Mexico on runway 17 to end STS-3 mission.
 April 6, 1982
 Columbia ferried from WSMR, New Mexico to KSC.
 April 7, 1982
 Columbia at OPF for preparations of fourth flight.
 May 16, 1982
 Columbia transferred from OPF to VAB for mating.
 May 25, 1982
 Mated STS-4 transported from VAB to LC-39A.
 June 27, 1982
 Columbia launched on fourth flight, STS-4.

July 4, 1982
 Columbia landed at EAFB on runway 22 to complete STS-4 mission.
 July 14, 1982
 Columbia ferried from EAFB to KSC.
 July 15, 1982
 Columbia at OPF for turnaround for fifth flight.
 September 9, 1982
 Columbia transferred from OPF to VAB for mating.
 September 21, 1982
 Mated STS-5 transported from VAB to LC-39A.
 November 11, 1982
 Columbia launched on fifth flight, STS-5.
 November 16, 1982
 Columbia landed at EAFB on runway 22 to complete STS-5 mission.
 November 21, 1982
 Columbia ferried from EAFB to KSC.
 November 23, 1982
 Columbia at OPF for modifications for STS-9/Spacelab-1 mission.
 September 23, 1983
 Columbia transferred from OPF to VAB for mating.
 September 28, 1983
 Mated STS-9 transported from VAB to LC-39A for sixth flight.
 October 17, 1983
 Mated STS-9 rolled back from LC-39A to VAB.
 October 19, 1983
 Columbia transferred from VAB to OPF.
 November 3, 1983
 Columbia transferred from OPF to VAB for remate.
 November 8, 1983
 Mated STS-9 transported from VAB to LC-39A for sixth flight.
 November 28, 1983
 Columbia launched on its sixth flight, STS-9.
 December 8, 1983
 Columbia landed at EAFB on runway 17 to complete STS-9 mission.
 December 14, 1983
 Columbia ferry flight from EAFB to Kelly AFB, Texas.
 December 15, 1983
 Columbia ferry flight from Kelly AFB, Texas to Eglin AFB, Florida, to KSC
 December 16, 1983
 Columbia transferred to OPF.
 January 26, 1984
 Columbia ferried from KSC to Kelly AFB, Texas.
 January 27, 1984
 Columbia ferried from Kelly AFB, Texas to EAFB.
 January 30, 1984
 Columbia overland from NASA Dryden Flight Research Facility, California, to Rockwell International assembly facility at Palmdale, California.
 July 11, 1985
 Overland transport of Columbia from Rockwell assembly facility at Palmdale to EAFB.
 July 14, 1985
 Columbia ferried from EAFB to Offutt AFB, Nebraska.
 July 14, 1985
 Columbia ferry flight from Offutt AFB, Nebraska, to KSC.
 July 16, 1985
 Columbia transferred from mate/demate device to VAB transfer aisle.
 July 18, 1985

Columbia transferred from VAB transfer aisle to OPF.

September 8, 1985
Columbia transferred from OPF to VAB for temporary storage.

September 26, 1985
Columbia transferred from VAB to OPF.

November 22, 1985
Columbia transferred from OPF to VAB for mating.

December 1, 1985
Columbia transported from VAB to LC-39A for seventh flight, STS 61-C.

December 19, 1985
Columbia launch scrubbed at T-13 seconds due to right-hand SRB APU overspeed.

January 6, 1986
Columbia launch scrubbed at T-31 seconds due to LOX valve problem.

January 7, 1986
Columbia launch scrubbed at T-9 minutes due to adverse weather at TAL site.

January 10, 1986
Columbia launch scrubbed at T-9 minutes due to adverse weather at KSC.

January 12, 1986
Columbia launched on seventh flight, STS 61-C.

January 18, 1986
Columbia landed at EAFB on runway 22 to complete STS 61C mission.

January 22, 1986
Columbia ferry flight from EAFB to Davis-Monthan AFB, Arizona, to Kelly AFB, Texas.

January 23, 1986
Columbia ferried from Kelly AFB to Eglin AFB, Florida, to KSC.

January 23, 1986
Columbia transported to OPF.

June 24, 1986
Columbia transferred from OPF bay 1 to bay 2.

March 13, 1987
Columbia transferred from OPF bay 2 to VAB high bay 2 for storage.

September 9, 1987
Columbia transferred from VAB high bay 2 to OMRF.

July 8, 1988
Columbia transferred from OMRF to OPF bay 1.

October 7, 1988
Columbia transferred from OPF bay 1 to OMRF.

November 9, 1988
Columbia transferred from OMRF to OPF bay 2.

December 10, 1988
Columbia transferred from OPF bay 2 to OMRF.

January 23, 1989
Columbia transferred from OMRF to OPF bay 1.

July 3, 1989
Columbia rollover from OPF bay 1 to VAB for mating.

July 14, 1989
Columbia mated for STS-28 mission transported from VAB to LC-39B.

August 8, 1989
Columbia launched on eighth flight, STS-28.

August 13, 1989
Columbia landed at EAFB on runway 17 to complete STS-28 mission.

August 20, 1989
Columbia ferried from EAFB to Sheppard AFB, Texas, to Warner Robins, Georgia.

August 21, 1989
Columbia ferried from Warner Robins, Georgia to KSC.

August 22, 1989

Columbia in OPF bay 2.

November 16, 1989
Columbia rollover from OPF bay 2 to VAB for mating.

November 28, 1989
Columbia mated for STS-32, transported from VAB to LC-39A.

January 9, 1990
Columbia launched on its ninth flight, STS-32.

January 20, 1990
Columbia landed at EAFB runway 22 to complete STS-32 mission.

January 25, 1990
Columbia ferry flight from EAFB to Davis-Moahan AFB, Arizona, then to Kelly AFB, Texas.

January 26, 1990
Columbia ferry flight from Kelly AFB to Eglin AFB, Florida, to KSC.

January 27, 1990
Columbia in OPF bay 1.

April 16, 1990
Columbia rollover from OPF bay 1 to VAB for mating.

April 22, 1990
Columbia mated for STS-35 transported from VAB to LC-39A.

May 29, 1990
STS-35 launch scrubbed due to hydrogen leak.

June 12, 1990
Columbia rollback from LC-39A to VAB for demate.

June 15, 1990
Columbia rolled over from VAB to OPF bay 2.

August 2, 1990
Columbia rolled over from OPF bay 2 to the VAB for remate.

August 9, 1990
Columbia transported from VAB to LC-39A.

September 5, 1990
STS-35 launch scrubbed due to hydrogen leak.

September 17, 1990
STS-35 launch scrubbed due to hydrogen leak.

October 8, 1990
Columbia transported from LC-39A to LC-39B.

October 9, 1990
Columbia transported from LC-39B to VAB due to tropical storm.

October 14, 1990
Columbia mated for STS-35, transported from VAB to LC-39B.

October 30, 1990
Columbia taking test at LC-39B successful.

December 2, 1990
Columbia launched on its tenth flight, STS-35.

December 10, 1990
Columbia landed at EAFB on runway 22 to complete STS-35 mission.

December 18, 1990
Columbia ferried from EAFB to Biggs Army Air Base, Texas to Kelly AFB.

December 19, 1990
Columbia ferried from Kelly AFB to Barksdale AFB, Louisiana.

December 20, 1990
Columbia ferried from Barksdale AFB, Louisiana to KSC.

December 21, 1990
Columbia transported to VAB.

February 1991
Columbia rollover from VAB to OPF bay 1.

April 26, 1991

Columbia transported from OPF bay 1 to VAB

May 2, 1991
Columbia mated for STS-40, transported from VAB to LC-39B.

June 1, 1991
STS-40 launch scrubbed due to inertial measurement unit.

June 5, 1991
Columbia launched on its 11th mission, STS-40.

June 14, 1991
Columbia landed at EAFB on runway 22 to complete STS-40 mission.

June 19, 1991
Columbia ferried from EAFB to Biggs Army Air Base, Texas.

June 20, 1991
Columbia ferried from Biggs AAB to Kelly AFB to Columbus AFB, Mississippi.

June 21, 1991
Columbia ferried from Columbus AFB to KSC.

June 21, 1991
Columbia transported to OPF bay 2.

August 7, 1991
Columbia transferred from OPF bay 2 to OPF bay 3.

August 8, 1991
Columbia transferred from OPF bay 3 to KSC Shuttle Landing Facility.

August 10, 1991
Columbia ferried from KSC to McDill AFB, Florida.

August 12, 1991
Columbia ferried from McDill AFB to Kelly AFB, Texas

August 13, 1991
Columbia ferried from Kelly AFB to Rockwell International assembly facility, Palmdale, California.

February 9, 1992
Columbia ferried from Rockwell assembly facility to Kelly AFB, Texas, to KSC.

February 9, 1992
Columbia transported to OPF bay 3.

May 29, 1992
Columbia transferred from OPF bay 3 to VAB.

June 3, 1992
Columbia mated for STS-50, transported from VAB to LC-39A.

June 25, 1992
Columbia launched on its 12th flight, STS-50.

July 9, 1992
Columbia lands at KSC runway 33 to complete STS-50 mission.

July 9, 1992
Columbia transported to OPF bay 1.

September 21, 1992
Columbia transferred from OPF bay 1 to VAB high bay 1.

September 26, 1992
Columbia mated for STS-52, transported from VAB to LC-39B.

October 22, 1992
Columbia launched on its 13th flight, STS-52.

November 1, 1992
Columbia lands at KSC runway 33 to complete STS-52 mission.

November 1, 1992
Columbia transported to OPF bay 2.

February 3, 1993
Columbia transferred from OPF bay 2 to VAB.

February 7, 1993
Columbia mated for STS-55, transported from VAB to LC-39A.

March 22, 1993
Launch of STS-55 scrubbed at T-3 seconds due to LOX valve leak on SSME #3.

April 6, 1993
Launch of STS-55 scrubbed at T-11 seconds due to faulty instrumentation.

April 26, 1993
Columbia launched on its 14th flight, STS-55.

May 6, 1993
Columbia landed at EAFB on runway 22 to complete STS-55 mission.

May 11, 1993
Columbia ferried from EAFB to Biggs AAF.

May 12, 1993
Columbia ferried from Biggs AAF to Kelly AFB, Texas

May 14, 1993
Columbia ferried from Kelly AFB to Columbus AFB, Mississippi, to KSC.

May 14, 1993
Columbia transported to OPF bay 2.

August 11, 1993
Columbia transferred from OPF bay 2 to VAB high bay 3.

September 16, 1993
Columbia mated for STS-58, transported from VAB to LC-39B.

September 17, 1993
Columbia on the pad at LC-39B.

October 14, 1993
Launch of STS-58 scrubbed due to failure of range safety processor.

October 15, 1993
Launch of STS-58 scrubbed due to failure of S-band transponder.

October 18, 1993
Columbia launched on its 15th flight, STS-58.

November 1, 1993
Columbia landed at EAFB on runway 22 to complete STS-58 mission.

November 7, 1993
Columbia ferried from EAFB to Columbus AFB, Mississippi.

November 8, 1993
Columbia ferried from Columbus AFB to KSC.

November 8, 1993
Columbia transported to OPF bay 2.

February 3, 1994
Columbia transferred from OPF bay 2 to VAB.

February 10, 1994
Columbia mated for STS-62, transported from VAB to LC-39B.

March 3, 1994
Launch of STS-62 postponed 24 hours due to weather.

March 4, 1994
Columbia launched on its 16th flight, STS-62.

March 18, 1994
Columbia lands at KSC runway 33 to complete STS-62 mission.

March 18, 1994
Columbia transported to OPF bay 2.

June 8, 1994
Columbia transferred from OPF bay 2 to VAB.

June 14-15, 1994
Columbia mated for STS-65, transported from VAB to LC-39A.

July 8, 1994
Columbia launched on its 17th flight, STS-65.

July 23, 1994
Columbia lands at KSC runway 33 to complete STS-65 mission.

July 23, 1994
 Columbia transported to OPF bay 1.
 October 7, 1994
 Columbia transferred from OPF bay 1 to SLF.
 October 8, 1994
 Columbia ferried from KSC to Huntsville, Alabama.
 October 10, 1994
 Columbia ferried from Huntsville, to Ellington Field, Texas
 October 11, 1994
 Columbia ferried from Ellington Field to Biggs AAF, to Rockwell modification facility.
 April 11, 1995
 Columbia ferried from Rockwell's Facility to Ellington Field, Texas.
 April 14, 1995
 Columbia ferried from Ellington Field to KSC.
 April 15, 1995
 Columbia transported to VAB bay 2.
 April 21, 1995
 Columbia transferred from VAB bay 2 to OPF bay 3.
 August 21, 1995
 Columbia transferred from OPF bay 3 to VAB.
 August 28, 1995
 Columbia mated for STS-73, transported from VAB to LC-39B.
 September 28, 1995
 Launch of STS-73 postponed due to leak in main fuel valve, SSME #1.
 October 4, 1995
 Launch of STS-73 postponed 24 hours due to high winds associated with Hurricane Opal.
 October 6, 1995
 Launch of STS-73 postponed 24 hours due to problem with No. 1 hydraulic system.
 October 7, 1995
 Launch of STS-73 scrubbed at T-20 minute mark due to failure of master events controller.
 October 13, 1995
 Launch of STS-73 postponed 24 hours due to crack on engine at Stennis after test.
 October 15, 1995
 Launch of STS-73 postponed due to unacceptable weather at KSC.
 October 15, 1995
 Columbia launched on its 18th flight, STS-73.
 November 5, 1995
 Columbia lands at KSC runway 33 to complete STS-73 mission.
 November 5, 1995
 Columbia transported to OPF bay 2.
 January 23, 1996
 Columbia transferred from OPF bay 2 to VAB.
 January 29, 1996
 Columbia mated for STS-75, transferred from VAB to LC-39B.
 February 22, 1996
 Columbia launched on its 19th flight, STS-75.
 March 9, 1996
 Columbia lands at KSC runway 33 to complete STS-75 mission.
 March 9, 1996
 Columbia transported to OPF bay 2.
 May 21, 1996
 Columbia transferred from OPF bay 2 to VAB.
 May 29, 1996
 Columbia mated for STS-78, transferred from VAB to LC-39B.
 June 20, 1996
 Columbia launched on its 20th flight, STS-78.

July 7, 1996
Columbia lands at KSC runway 33 to complete STS-78 mission.

July 7, 1996
Columbia transported to OPF bay 1.

October 9, 1996
Columbia transferred from OPF bay 1 to VAB.

October 16, 1996
Columbia mated for STS-80, transferred from VAB to LC-39B.

November 4, 1996
Launch of STS-80 postponed due to SRB nozzle erosion on STS-79 launch.

November 13, 1996
Launch of STS-80 postponed due to predicted bad weather.

November 19, 1996
Columbia launched on its 21st flight, STS-80.

December 7, 1996
Columbia lands at KSC runway 33 to complete STS-80 mission.

December 7, 1996
Columbia transported to OPF bay 1

March 5, 1997
Columbia transferred from OPF bay 1 to VAB.

March 11, 1997
Columbia mated for STS-83, transferred from VAB to LC-39A.

April 4, 1997
Columbia launched on its 22nd flight, STS-83.

April 8, 1997
Columbia lands at KSC runway 33 to complete STS-83 mission.

April 8, 1997
Columbia transported to OPF bay 1.

June 4, 1997
Columbia rolled over from OPF bay 1 to VAB.

June 11, 1997
Columbia mated for STS-94, transferred from VAB to LC-39A.

July 1, 1997
Columbia launched on its 23rd flight, STS-94.

July 17, 1997
Columbia lands at KSC runway 33 to complete STS-94 mission.

July 17, 1997
Columbia transported to OPF bay 2.

October 24, 1997
Columbia rolled over from OPF bay 2 to VAB transfer aisle.

October 29, 1997
Columbia mated for STS-87, transferred from VAB to LC-39B.

November 19, 1997
Columbia launched on its 24th flight, STS-87

December 5, 1997
Columbia lands at KSC runway 33 to complete STS-87 mission.

December 5, 1997
Columbia transported to OPF bay 3.

March 16, 1998
Columbia rolled over from OPF bay 3 to VAB.

March 23, 1998
Columbia mated for STS-90, transported from VAB to LC-39B.

April 16, 1998
Launch of STS-90 postponed for 24 hours due to network signal failure.

April 17, 1998
Columbia launched on its 25th flight, STS-90.

May 3, 1998
Columbia lands at KSC runway 33 to complete STS-90 mission.

May 3, 1998
Columbia transported to OPF bay 3.

February 10, 1999
Columbia transferred from OPF bay 3 to VAB high bay 2 for temporary storage.

April 15, 1999
Columbia transferred from VAB high bay 2 to OPF bay 1.

June 2, 1999
Columbia transferred from OPF to VAB.

June 7, 1999
Columbia mated for STS-93, transported from VAB to LC-39B.

July 20, 1999
Launch of STS-93 scrubbed at T-7 seconds due to hazardous gas in aft engine compartment.

July 22, 1999
Launch of STS-93 postponed 24 hours due to weather

July 23, 1999
Columbia launched on 26th flight, STS-93.

July 27, 1999
Columbia lands at KSC runway 33 to complete STS-93 mission.

July 27, 1999
Columbia transported to OPF bay 3.

September 24, 1999
Columbia is ferried from KSC to Whiteman AFB, Missouri.

September 25, 1999
Columbia is ferried from Whiteman AFB to Rockwell maintenance facility in Palmdale.

March 1, 2001
Columbia is ferried from Palmdale to Dyess AFB, Texas.

March 3, 2001
Columbia is ferried from Dyess AFB to KSC.

March 3, 2001
Columbia is transported to OPF bay 1.

May 8, 2001
Columbia transferred from OPF to VAB to make way for Endeavour.

May 29, 2001
Columbia transferred from VAB to OPF.

January 16, 2002
Columbia transferred from OPF to VAB.

January 28, 2002
Columbia mated for STS-109, transported from VAB to LC-39A.

February 28, 2002
Launch of STS-109 postponed due weather.

March 1, 2002
Columbia launched on 27th flight, STS-109.

March 12, 2002
Columbia lands at KSC runway 33 to complete STS-109 mission.

March 12, 2002
Columbia transported to OPF.

November 18, 2002
Columbia transferred from OPF to VAB

December 9, 2002
Columbia mated for STS-107, transported from VAB to LC-39A.

January 16, 2003
Columbia launched on 28th flight, STS-107.

February 1, 2003
Columbia broke up during re-entry due to structural damage on left wing.

DFRC	Dryden Flight Research Center
EAFB	Edwards Air Force Base
ET	External Tank
LC-39A	Launch Complex 39 pad A
LC-39B	Launch Complex 39 pad B
OPF	Orbiter Processing Facility
OV	Orbiter Vehicle
RCS	Reaction Control System
SRB	Solid Rocket Boosters
SCA	Shuttle Carrier Aircraft
VAB	Vehicle Assembly Building
WSMR	White Sands Missile Range

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Appendix C

DATE	SPACE SHUTTLE EVENTS	MISSION
03/24/1979	First time a Space Shuttle was transported to its launching base when Columbia arrived at Kennedy Space Center.	Columbia
02/20/1981	First Flight Readiness Firing [FRF] of Shuttle main engines.	STS 1 [Columbia]
04/12/1981	First flight of Space Transportation System reusable winged space vehicle which provided the first successful retrieval of the Solid Rocket Boosters [SRB] on 4/13/1981.	STS 1 [Columbia]
11/12/1981	First re-use of a crew assisted space vehicle.	STS 2 [Columbia]
03/22/1982	First Space Shuttle landing at White Sands.	STS 3 [Columbia]
06/27/1982	First Getaway Specials aboard a shuttle mission.	STS 4 [Columbia]
11/11/1982	First operational STS mission. First deployment of two commercial communications satellites. First spacecraft crew of four. First flight of mission specialist astronauts [J. Allen & W. Lenoir].	STS 5 [Columbia]
11/28/1983	First mission of a reusable, scientific research facility [Spacelab-1]. First rollback of orbiter from Launch Complex 39A to Vehicle Assembly Building. First flight with six crew members in single spacecraft. First European Space Agency [ESA] astronaut representative [U. Merbold]. First Non-NASA astronauts to fly on the Shuttle. [B. Lichtenberg/U. Merbold]	STS 9 [Columbia]
01/12/1986	First flight of Columbia after major modifications. First Hispanic astronaut to fly in space. [F. R. Chang-Diaz]	STS 61C [Columbia]
06/25/1992	First Extended Duration Orbiter mission. First flight for orbiter after extensive modifications at Rockwell in California. First flight of the U.S. Microgravity Laboratory-1 [USML-1]. First landing at Kennedy Space Center [KSC] for orbiter. First landing with new synthetic tread tires	STS 50 [Columbia]
07/08/1994	First Japanese woman to fly in space [C. Naito-Mukai]; she also set record for longest flight to date by female astronaut. First Japanese to fly in space twice. [C.Mukai]. First time liftoff and re-entry as experienced from crew cabin captured on tape	STS 65 [Columbia]
06/20/1996	First occurrence of combustion product penetration into the J-joint of redesigned solid rocket motor [RSRM]. First live downlink video during orbiter's descent.	STS 78 [Columbia]
11/19/1996	First time 2 free-flying research spacecraft deployed and retrieved [ORFEUS-SPAS II and the Wake Shield Facility-3].	STS 80 [Columbia]
04/04/1997	First flight of the Microgravity Science Laboratory-1 [MSL-1]	STS 83 [Columbia]
07/01/1997	First re-flight of same vehicle, crew and payloads.	STS 94 [Columbia]
11/19/1997	First Heads-Up ascent during first stage of liftoff. First East Indian woman from India to fly in space. [K. Chawla]	STS 87 [Columbia]
04/17/1998	First Kennedy Space Center employee to be chosen as an astronaut and to fly on Space Shuttle mission [K. Hire].	STS 90 [Columbia]
07/23/1999	First flight with female mission commander [E. Collins].	STS 93 [Columbia]
03/05/2001	First time two Shuttles have been ferried simultaneously. [Atlantis returning from Edwards Air Force Base and Columbia returning from Palmdale after modifications].	Atlantis to SLF Columbia to CCAFS
01/16/2003	First Israeli astronaut to fly in space. [I. Ramon]. First re-entry accident involving a space shuttle. [02/01/2003]	STS 107 [Columbia]

Web posted. (2003). [United States Space Program Firsts, KHR-18 [Online]. Available WWW: <http://www-pao.ksc.nasa.gov/history/documents.htm> [2003, December].]

Appendix D

Flight # Vehicle # vehicle flights Total # flights	Crew	Duration Days/Hours/Mins. Hours Elapsed Orbits Statute Miles	Date Launch Landing Location	Time Launch Landing (Main gear)
STS-1 Columbia 1st 1st	John W. Young, CDR Robert L. Crippen, Plt	02/06:20:53.1 54:20:53.1 36 933,757	Apr-12-81 Apr-14-81 EAFB	6:00 a.m. CST 12:20 p.m. CST
STS-2 Columbia 2nd 2nd	Joe H. Engle, CDR Richard H. Truly, Plt	02/06:13:12 54:13:12 36 933,757	Nov-12-81 Nov-14-81 EAFB	9:10 a.m. CST 3:23 p.m. CST
STS-3 Columbia 3rd 3rd	Jack Lousma, CDR Gordon Fullerton, Plt	08/00:04:49 192:04:49 129 3,900,000	Mar-22-82 Mar-30-82 Northrup Strip US Army, White Sands Missile Range, NM	10:00 a.m. CST 10:04 a.m. CST
STS-4 Columbia 4th 4th	T.K. Mattingly, CDR Henry Hartsfield, Plt	07/01:11:11 169:11:11 112 2,900,000	Jun-27-82 Jul-04-82 EAFB	09:59:59 a.m. CDT 11:11:11 a.m. CDT
STS-5 Columbia 5th 5th	Vance Brand, CDR Robert Overmyer, Plt Joe Allen, MS Bill Lenoir, MS	5/02:14:27 122:14:27 81 1,850,000	Nov-11-82 Nov-16-82 EAFB	06:19:00 a.m. CST 08:33:27 a.m. CST
STS-9 Columbia 6th 9th	John W. Young, CDR Brewster H. Shaw, Jr., Plt Owen K. Garriott, MS Robert A. Parker, MS Byron Lichtenberg, PS Ulf Merbold, PS	10/7:47:24 247:47:24 148 3,330,000	Nov-28-83 Dec-08-83 EAFB	10:00:00 a.m. CST 05:47:24 p.m. CST
STS 61-C Columbia 7th 24th	Robert L. Gibson, CDR Charles F. Bolden, Plt Franklin Chang-Diaz, MS Steven A. Hawley, MS George D. Nelson, MS Robert J. Cenker, RCA PS Congressman Bill Nelson	06/02:03:51 146:03:51 96 2,197,305	Jan-12-86 Jan-18-86 EAFB	05:55:00 a.m. CST 07:58:51 p.m. CST
STS-28 Columbia 8th 30th	Brewster H. Shaw, CDR Richard N. Richards, Plt James C. Adamson, MS David C. Leestma, MS Mark N. Brown, MS	05/01:00:53 121:00:53 80 2,070,943	Aug-08-89 Aug-13-89 EAFB	07:37:00 a.m. CDT 08:37:53 a.m. CDT

Flight # Vehicle # vehicle flights Total # flights	Crew	Duration Days/Hours/Mins. Hours Elapsed Orbits Statute Miles	Date Launch Landing Location	Time Launch Landing (Main gear)
STS-32 Columbia 9th 33rd	Daniel C. Brandenstein, CDR James D. Wetherbee, Plt Bonnie J. Dunbar, MS G. David Low, MS Marsha S. Ivins, MS	10/21:01:38 261:01:38 173 4,509,972	Jan-09-90 Jan-20-90 EAFB	06:35:00 a.m. CST 03:36:38 a.m. CST
STS-35 Columbia 10th 38th	Vance D. Brand, CDR Guy S. Gardner, Plt Jeffrey A. Hoffman, MS John M. Lounge, MS Robert A.R. Parker, MS Samuel T. Durrance, PS Ronald Parise, PS	08/23:05:08 215:05:08 142 3,728,636	Dec-02-90 Dec-10-90 EAFB	12:49:01 a.m. CST 11:54:09 p.m. CST
STS-40 Columbia 11th 41st	Bryan D. O'Connor, CDR Sidney M. Gutierrez, Plt M. Rhea Seddon, MS James P. Bagian, MS Tamara E. Jernigan, MS F. Drew Gaffney, PS Millie Hughes-Fulford, PS	09/2:14:20 218:14:20 146 3,290,226	Jun-05-91 Jun-14-91 EAFB	08:24:51 a.m. CDT 10:39:11 a.m. CDT
STS-50 Columbia 12th 48th	Richard N. Richards, Cdr Kenneth D. Bowersox, Plt Bonnie J. Dunbar, MS-PL Cdr Ellen Baker, MS Carl J. Meade, MS Lawrence J. DeLucas, PS Eugene H. Trinh, PS	13/19:30:04 331:30:04 221 5,758,332	Jun-25-92 Jul-09-92 KSC	11:12 a.m. CDT 6:42 a.m. CDT
STS-52 Columbia 13th 51st	James D. Wetherbee, CDR Michael A. Baker, Plt Charles Lacy Veach, MS1 William M. Shepherd, MS2 Tamara E. Jernigan, MS3 Steven G. MacLean, PS1	9/20:56:13 236:56:13 159 4,129,028	Oct-22-92 Nov-01-92 KSC	12:09 p.m. CDT 8:05 a.m. CST
STS-55 Columbia 14th 55th	Steven R. Nagel, CDR Terence T. Henricks, Plt Jerry L. Ross, MS1 Charles J. Precourt MS2 Bernard A. Harris, Jr., MS3 Ulrich Walter, PS1 Hans William Schlegel, PS2	9/23:39:59 239:40:00 160 4,164,183	Apr-26-93 May-06-93 EAFB	09:50 a.m. CDT 09:30 a.m. CDT
STS-58 Columbia 15th 58th	John E. Blaha, CDR Richard A. Searfoss, Plt M. Rhea Seddon, PC, MS1 William S. McArthur, MS2 David A. Wolf, MS3 Shannon W. Lucid, MS4 Martin J. Fettman, PS	14/00:12:32 336:13:01 225 5,840,450	Oct-18-93 Nov-01-93 EDW	09:53 a.m. CDT 09:06 a.m. CST

Flight # Vehicle # vehicle flights Total # flights	Crew	Duration Days/Hours/Mins. Hours Elapsed Orbits Statute Miles	Date Launch Landing Location	Time Launch Landing (Main gear)
STS-62 Columbia 16th 61st	John H. Casper, CDR Andrew M. Allen, Plt Pierre J. Thout, MS1 Charles "Sam" Gemar, MS2 Marsha S. Ivins, MS3	13/23:16:41 335:16:00 224 5,820,146	Mar-04-94 Mar-18-94 KSC	07:53 a.m. CST 07:09 a.m. CST
STS-65 Columbia 17th 63rd	Robert D. Cabana, Cdr James D. Halsell, Jr., Pilot Richard J. Hieb, PLC, MS1 Carl E. Walz, MS2 Leroy Chiao, MS3 Donald A. Thomas, MS4 Chiaki Naito-Mukai, PS1	14/17:55:00 353:55:00 236 6,143,846	Jul-08-94 Jul-23-94 KSC	11:43 a.m. CDT 5:38 a.m. CDT
STS-73 Columbia 18th 72nd	Ken Bowersox, Cdr Kent Rominger, Plt Catherine Coleman, MS1 Michael Lopez-Alegria, MS2 Kathryn Thornton, MS3 Fred Leslie, PS1 Albert Sacco, PS2	15/21:52:21 381:52:00 256 6,600,000	Oct-20-95 Nov-05-95 KSC	8:53 a.m. CDT 5:45 a.m. CST
STS-75 Columbia 19th 75th	Andrew M. Allen, Cdr Scott J. Horowitz, Plt Jeffrey A. Hoffman, MS1 Maurizio Cheli, MS2 Claude Nicollier, MS3 Franklin R. Chang-Diaz, MS4, PLC Umberto Guidoni, PS1	15/17:40:21 377:40:00 252 6,500,000	Feb-22-96 Mar-09-96 KSC	2:18 p.m. CST 7:58 a.m. CST
STS-78 Columbia 20th 78th	Tom Henricks, Cdr Kevin Kregel, Plt Rick Linnehan, MS1 Susan Helms, MS2, PLC Chuck Brady, MS3 Jean-Jacques Favier, PS1 Bob Thirsk, PS2	16/21:47:35 405:48:00 271 7,046,000	Jun-20-96 Jul-07-96 KSC	9:49 a.m. CDT 7:37 a.m. CDT
STS-80 Columbia 21st 80th	Ken Cockrell, Cdr Kent Rominger, Plt Tamara Jernigan, MS1 Tom Jones, MS2 Story Musgrave, MS3	17/15:53:17 423:53:00 278 7,043,950	Nov-19-96 Dec-07-96 KSC	1:56 p.m. CST 5:49 a.m. CST
STS-83 Columbia 22nd 83rd	Jim Halsell, Cdr Susan Still, Plt Janice Voss, PC, MS1 Mike Gernhardt, MS2 Don Thomas, MS3 Roger Crouch, PS1 Greg Linteris, PS2	3/23:12:39 95:12:00 63 1,500,000	Apr-04-97 Apr-08-97 KSC	1:21 p.m. CST 1:33 p.m. CDT

Flight # Vehicle # vehicle flights Total # flights	Crew	Duration Days/Hours/Mins. Hours Elapsed Orbits Statute Miles	Date Launch Landing Location	Time Launch Landing (Main gear)
STS-94 Columbia 23rd 85th	Jim Halsell, Cdr Susan Still, Plt Janice Voss, PC, MS1 Mike Gernhardt, MS2 Don Thomas, MS3 Roger Crouch, PS1 Greg Linteris, PS2	15/16:44:33 376:45:00 251 6,200,000	Jul-01-97 Jul-17-97 KSC	1:02 p.m. CDT 5:47 a.m. CDT
STS-87 Columbia 24th 88th	Keven Kregel, Cdr Steve Lindsey, Plt Kalpana Chawla, MS1 Winston Scott, MS2 Takao Doi, MS3 Leonid Kadenyuk, PS1	15/16:34:04 376:34:00 251 6,544,000	Nov-19-97 Dec-05-97 KSC	1:46 p.m. CST 6:20 a.m. CST
STS-90 Columbia 25th 90th	Rick Searfoss, Cdr Scott Altman, Plt Rick Linnehan, MS1, PLC Kay Hire, MS2 Daffyd (Dave) Williams, MS3 Jay Buckey, PS1 James Pawelczyk, PS2	15/21:49:59 381:50:00 255 6,375,000	Apr-17-98 May-03-98 KSC	1:19 p.m. CDT 11:09 a.m. CDT
STS-93 Columbia 26th 95th	Eileen Collins, CDR Jeff Ashby, PLT Cady Coleman, MS1 Steve Hawley, MS2 Michel Tognini, MS3	4/22:49 118:49:00 79 1,796,000	Jul-22-99 Jul-27-99 KSC	11:31p.m. CDT 10:21p.m. CDT
STS-109 Columbia 27th 108th	Scott Altman, CDR Duane Carey, PLT John Grunsfeld, MS1, PLC Nancy Currie, MS2 Rick Linnehan, MS3 Jim Newman, MS4 Mike Massimino, MS5	10/22:10 262:10:00 165 3,941,705	Mar-1-02 Mar-12-02 KSC	5:22 am CST 3:32 am CST
STS-107 Columbia 28th 113th	Rick Husband, CDR William McCool, PLT Dave Brown, MS1 Kalpana Chawla, MS2 Mike Anderson, MS3 Laurel Clark, MS4 Ilan Ramon, PS1	15/22:20 382:20:00 255 6,649,757	Jan-16-2003 Feb-01-2003	9:39 am CST 7:59 am CST

Kay Grinter. (2003). E-mail: Subject: From NASA-JSC Newsroom in response to a public inquiry [2003, June 9].

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14. ABSTRACT This document is intended to serve as a record of KSC events and is a reference source for historians and other researchers. Arrangement is by day and month and individual articles are attributed to published sources. Materials were researched and described by the KSC Library Archivist for KSC Library Services Contractor, InDyne, Inc.					
15. SUBJECT TERMS Accident Investigation, Carbon carbon composites, Chronology, Columbia (orbiter), Debris, Expendable Launch Vehicles, External Tanks, Foam Insulation, Impact damage, International Space Station, Landings, Launch Schedule, Launches, Payloads, Reentry, Security, STS-107, Thermal insulation.					
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